TOPICS OF THE MONTH

Bright outlook for French petro-chemicals

THE French petro-chemical industry has been described by Dr. Pierre Rubé, of Naphtachimie—the French petro-chemical concern—as proceeding rapidly towards full recovery from the devastation of World War 2. As a convincing token of recovery, Dr. Rubé completed negotiations with the Scientific Design Co. Inc., New York, for the design and engineering of a major expansion programme planned for Naphtachimie's ethylene oxide plant in Lavera, France. The expanded plant will have a capacity nearly double its present 8,000 tons p.a. The total investment in the entire Lavera petro-chemical installation will exceed $30 million, thus representing the largest such project in continental Europe.

Dr. Rubé pointed out that the excellent recent progress of the French chemical industry was particularly encouraging, since its problems had been somewhat more serious than those of other industries shattered by the war. While French firms were closed, destroyed or appropriated, U.S. plants evolved new techniques and cheaper raw materials at a rate far greater than ever before. Recovery is attributed by Dr. Rubé to the general recovery of Europe and to the vital flow of technical know-how that has been passing in both directions between Europe and the U.S. Dr. Rubé cited Naphtachimie's new oxide plant as an example of this. The fundamental idea for the process in use there—direct oxidation of ethylene—was conceived in France over 20 years ago. The first commercial realisation, however, took place in the U.S. More recently, Scientific Design developed its own improved version and was then engaged by Naphtachimie to bring the process back to France and install it in the new Lavera plant, which went on stream in 1953, thus becoming the first facility in Europe to manufacture ethylene oxide by direct oxidation. The expansion of the Lavera plant will be completed by the middle of 1957.

With the new facility, Naphtachimie further strengthens its prominent position in the European ethylene oxide and glycol markets. The only other announced European producer of ethylene oxide by direct oxidation will be the Société Chimique des Dérives du Pétrole (Petrochim) in Antwerp, Belgium, whose plant and process are also being designed by Scientific Design.

Dr. Rubé saw in the ethylene oxide project, and its expansion, a typical case history of how recent growth has taken place in French petro-chemicals. The markets for ethylene oxide and glycol compounds, both manufactured in the Lavera plant, have been growing at a rapid rate owing in part to the increase in the use of automobiles in France (about 30% higher than two years ago). In addition, there has been good growth in the markets for glycol ethers and similar products employed in the paint and resin field—an increase brought about by the boost in new home construction and maintenance.

Exports of chemicals should also rise now that improved techniques have narrowed the gap between French and U.S. prices for finished oxide and glycol products, despite the generally higher cost of raw materials in France.

New Zealand seeks new uses for coal

NEW ZEALAND is primarily an agricultural and farming country and requires large supplies of artificial fertilisers.* Although a considerable quantity is manufactured in N.Z., this is insufficient for the needs of the country, and carbonisation of its coal with 1.2% of nitrogen will give appreciable quantities of ammonia. Sulphuric acid is also needed (87,399 tons of sulphur were imported in 1953). Several of the seams in New Zealand contain high percentages of organic sulphur. It appears to be very desirable that the possibility of burning such a coal (for example, Charleston lignite, which contains 6 to 10% of sulphur) for its sulphur content with the formation of sulphuric acid should be investigated. Such a scheme should be economic if coke ovens or some other process could be set up in the same locality for the production of coke and by-products including ammonia.

This line of attack was suggested by Prof. J. Ivon Graham, M.A., M.SC., M.INST.F. (of the University of Otago, Dunedin) at a meeting of the Institute of Fuel in London. He recalled that several schemes for the more efficient utilisation of coal in New Zealand have been suggested in recent years. One of these, put forward by Mr. A. B. Liner, in a paper to the Mining Conference held at the University of Otago in May 1953, for the utilisation of slack from the Stockton mine (situated nearly 3,000 ft. above sea level in the Buller coalfield), was by the *Disco* process. This will produce a low-temperature coke or smokeless fuel having a volatile matter of about 18% and a calorific value of approximately 13,250 with 5.9% ash.

Another project which has been mooted, by a Southland concern, is for the production of motor fuels from coal by the *Lurgi* high-pressure complete gasification process. The project has not yet received the Government support which the promoters are anxious to obtain; for such a process it seems essential to operate on a scale of at least 1 million tons of coal p.a. The sub-bituminous coal of Southland seems to be ideal for this process and it seems probable that a considerable quantity of the required coal could be obtained by open-casting.

With the present trend of New Zealand's railways

* In the three years 1951-53 approximately 12,000 tons of ammonium sulphate and 11,000 tons of ammonium nitrate were imported.

towards use of diesel electric and oil-burning engines, Prof. Ivon Graham believes that a serious attempt should be made to supply an appreciable fraction of the liquid fuel so used from home sources.

In the gas industry, the coal used is mainly from the west coast, but it is believed that some gas works are now trying a blend of non-caking with caking coal. In addition to the coal carbonised in gas works, 26,752 tons of sub-bituminous coal was treated in the plant of Waikato Carbonization Ltd. at Rolowaro during 1954, producing 49% of coke product or 13,109 tons, from which 13,187 tons of carbonettes were manufactured and 1,980 tons of 'char' sold. The creosote produced was 212,689 gal. and 255 tons of pitch. Another undertaking, Smokeless Fuel Co. Ltd., Christchurch, produced 5,466 tons of coke and 24,186 gal. of tar during 1954.

On the subject of coke, it was pointed out that no metallurgical coke is at present made in New Zealand, although more than 30 years ago the Westport Coal Co. had coke ovens for this purpose. Some metallurgical coke is imported into New Zealand from Australia at a cost of about £20/ton. There seems to be a need for a small coking plant to meet these requirements.

U.S. chemical industries in six acres

A REPORT on the 25th Exposition of Chemical Industries, held at Philadelphia in December 1955, confirms that the scope of the exposition is considerably wider than the title implies. There were 500 exhibitors occupying about 6 acres of floor space. Apart from one Canadian firm, there were no foreign exhibitors. Some 262 categories of exhibits were on show, ranging from abrasives to *x*-ray equipment and including second cousins of the chemical industries like air-conditioning equipment and flooring materials. In effect, it covered the production of chemicals, the entire range of chemical processing and the use of chemicals in many manufacturing industries, including foodstuffs, petroleum products, textiles, plastics and medicines.

It is, in fact, an ideal place for looking into the competition a British product would face, as the newest and best of the American industry is on show. The representatives of the exhibiting firms are in the main technical experts, not members of the sales staff, and the visitor has to go prepared for a lot of leg work as the exhibits are not laid out in classification.

As for participation by British firms, it is believed that the Exposition would give an outstanding opportunity to reach American industry, provided that it was tackled in the right way. Most exhibitors concentrated on showing one particular development and included other items only as a background. British participants, or their agents, would be well advised to follow this example, and it is doubted whether it would be worth their while to exhibit unless they had some item that is new to the United States' market as a main attraction.

Thus comments a circular from the Export Services Branch of the Board of Trade, London, which urges appropriate U.K. firms interested in the United States' market to at least visit the show. It points out that the exposition provides an outstandingly detailed review of developments in the U.S. chemical and associated industries and a visitor spending four days there would probably get as much information about new developments in these industries as he would obtain on a month's tour of the United States.

On this showing, the next Chemical Industries Exposition, to be held in New York in 1957, should be well worth a little 'leg work.'

Increased sulphate wood turpentine production

THERE are now 44 pulp mills in the southern United States operating the sulphate process with pine wood. The pine wood so used permits the recovery of from 1½ to 4 gal. of crude sulphate turpentine, or pulp mill liquid, per ton of pulp made. The recovery varies with local conditions and is estimated, with efficient recovery, to average 2½ gal.

The 7½ million tons of pine sulphate pulp produced in 1954 is the largest single segment of United States' wood pulp production. The manufacture of pine sulphate pulp has had a steady record of growth. Production has more than doubled in the last ten years and further expansion has been projected for many years ahead.

Unlike other turpentine-producing industries, pulp mills are not faced with the problem of diminishing supplies of suitable pine wood. Ample forest reserves are being assembled by pulp mills and good forestry practices will assure a perpetual supply calculated for half a century ahead. The rapid strides in mechanisation that are being made also promise to keep the cost of this pine wood to reasonable levels.

These considerations are discussed in a bulletin issued by the Sulphate Turpentine Division of the Pulp Chemicals Association, U.S., which describes the different kinds of turpentine, their methods of production, their relative size and their uses, with a concluding discussion of sulphate turpentine production and its uses. It is pointed out that crude sulphate turpentine may be expected to be produced in increasing volume for many years to come, not only because of the continued growth of pine sulphate pulp production, but also because of improvements in the efficiency of recovering turpentine. Pulp mills are well financed and well staffed with the technologists needed to accomplish this. With the growing demand for crude sulphate and sulphate wood turpentines they will have the incentive to justify the effort. So far the production of these turpentines has only been enough to keep pace with such demand as came along without much encouragement. This is changing, however, as users and potential users are becoming more familiar with the properties of crude sulphate and sulphate wood turpentines and with the advantages of such turpentines from a low-cost, industrial source with assured supplies of pine wood available the year round without serious regard for weather or season.

Furoic acid manufacture in Britain

FUROIC acid, previously imported from America, is now being manufactured in Great Britain in commercial quantities. A process has been evolved which yields a high-quality technical grade, containing not less than 98% furoic acid. There is a recrystallised grade also available, containing not less than 99.8% furoic acid.

The manufacturers are Howard Lloyd & Co. Ltd. of Batley, Yorkshire. Dr. H. A. Fisher, chief chemist of the company, who has been responsible for the development of the manufacturing process, states that it consists in the oxidation of furfural with the aid of an especially evolved catalyst and the establishment of the exact conditions for giving a pure acid of high yield.

Production is greater than foreseeable requirements and can be stepped up to satisfy any probable demand.

Furoic acid has been used in the manufacture of special photographic developers, photo-sensitive dyes, in the manufacture of synthetic resins, and in the refining of lubricating oils and resin. It has an application as a wetting agent in the moulding of grinding wheels; it is used as a bacteriocide and preservative and its esters are used as perfume and flavouring ingredients. Small quantities go into textile processing.

Gasification of coal using nuclear heat

TESTS to determine the feasibility of using the heat from nuclear reactions to produce gas from coal have begun in the United States. These tests are being carried out at the Bureau of Mines Appalachian Experimental Station at Morgantown, West Virginia, as the result of discussions between the Bureau and the Atomic Energy Commission regarding the possibility of using nuclear heat in high-temperature chemical processes. Although the Bureau is concerned with several such processes, its immediate interest is in the gasification of coal—a necessary first step in processes for producing synthetic liquid fuels from coal.

One experimental nuclear-heated test unit (but which is actually heated electrically and does not involve the use of nuclear heat) has already been built and another one is expected to be completed this spring. The three-fold objective of this preliminary work by the Bureau is: (a) to determine suitable materials for constructing such units; (b) to determine the heat transfer characteristics; and (c) to study other process variables.

The Atomic Energy Commission plans to have a preliminary engineering study made of factors that must be considered in the nuclear phase of the problem. A Bureau of Mines engineer will co-operate in this study.

Comical Engineering Situations

"I'M AFRAID YOU MISUNDERSTOOD ME, WILKINS —I SAID TURN IT OFF"

Columbium or niobium?

TWO recent events connected with the industrial development of columbium come as reminders of the change in the outlook for this one-time 'rare' metal. The first is the 50th anniversary of the first preparation of the pure metal by Werner von Bolton—this long after Blomstrand had reduced columbium chloride in hydrogen and Moissan had prepared an equally impure ingot by his electric furnace treatment of columbium oxide with sugar charcoal. Von Bolton, of the Berlin Siemens-Halske company, was searching for new metal filaments for electric lamps; hence when he found the sister element tantalum superior in this direction it meant that tantalum became developed industrially while columbium was neglected.

The second recent event, which has now attracted attention to columbium possibilities, was the visit by the Duke of Edinburgh to the Nigerian tin mines, which have stepped up production of columbite ore as by-product to the extent of £6½ million last year, this representing approximately 3,000 tons. With columbium one of the nuclear elements for atomic breeder reactors and with a further demand in constructing jet engines, the metal now enters on a new chapter in its history.

While the chemist will ask why there is controversy over the two names 'columbium' and 'niobium' for one element, the chemical engineer will find equal interest in the metal's corrosion resistance compared with tantalum and new alloys. The name 'columbium' originated when Charles Hatchett took a sample of American columbite ore—which had been sent to the Royal Society and left in the British Museum—fused it with potash, dissolved the melt, and with nitric acid brought down a new 'earth' containing an element he called columbium. Yet, when Heinrich Rose had proved that two elements were present in his sample of Bavarian columbite, he called the one accompanying tantalum 'niobium' after Niobe—goddess of tears

and reminiscent of all the tears shed in trying to separate the two sister elements. 'Niobium' became favoured in Europe, yet 'columbium' again became the name not only in America but also in university texts and lectures elsewhere.

Meeting changes in the chemical industry

THE importance to the scientist in industry of keeping a mind receptive to change was stressed recently by Sir Alexander Fleck, K.B.E., F.R.S., chairman of Imperial Chemical Industries Ltd., when he delivered the 58th Sir Robert Boyle Memorial Lecture at Oxford. He gave two examples from chemical history illustrating the need for a flexible outlook, the first concerning dyestuffs. Just a hundred years ago Perkins discovered a synthetic dyestuff, 'mauveine' —first of the so-called aniline dyestuffs. A thriving industry rapidly developed, yet within 25 years it had begun to wither, while the German dyestuffs industry forged ahead. Had there been in the British industry a more receptive mood to change, based on a wider organic chemical industry and knowledge, the virtual destruction of the industry for the best part of 40 years might not have been brought about.

In the case of sodium carbonate, from 1825-75 Britain built up a magnificent business in the manufacture of soda ash by the Le Blanc process: sodium chloride→sodium sulphate→sodium carbonate. The potentialities of the ammonia soda method (sodium chloride→sodium bicarbonate) then became evident. There were numbers of technologists who recognised the strong points of the new process and it went on to win its permanent place for soda ash manufacture in spite of some gallant rearguard actions by the black-ash people.

Sir Alexander went on to give two other examples, this time from modern technology, where changing methods required a new approach which was recognised in time by the scientists concerned. The first was ammonia, a vitally important commodity to Britain. All synthetic ammonia used to come through coal or coal derivatives to remove the oxygen from the air and from water to give appropriate quantities of nitrogen and hydrogen. In the mid-1930s coal was so plentiful that Britain was looking for additional means of using it. To produce petrol, several million pounds were spent on a plant for this purpose. But now, to meet changing technical conditions in time, ammonia production is now being switched from coal to imported oil.

The final example is the production of metallic titanium, primarily to meet the need of jet aircraft engines. A chemical reaction, known for a very long while, of reacting metallic sodium with titanium tetrachloride to give metallic titanium and sodium chloride, was taken. Much technological work was done to transfer this reaction into a chemical process capable of yielding regularly several tons per day. Once more, the need for this method was recognised early and arrangements to meet changing circumstances were made in good time.

New chemical industry uses for reinforced plastics

THE use of reinforced polyester resins in the chemical industry, already extensive, is 'only the beginning,' according to Mr. D. G. Estey, of the American Cyanamid Co.'s Plastics and Resins Division. At a meeting of America's Society of the Plastics Industry, held in Atlantic City recently, he pointed out that, in many cases, reinforced polyesters have proved superior to metals and other materials used for equipment for containing corrosive chemicals. He predicted that the chemical industry will prove to be one of the biggest and best customers of reinforced polyester fabricators.

He further pointed out that, although tests are continually made to screen the various types of structures, the real factor which dictates success or failure of reinforced polyester structures is the history of actual installations. He noted successful applications in several instances. One of these is that, in several plants, pressure-moulded reinforced polyester trays are completely replacing steel, enamelled steel, stainless steel, *Monel* and aluminium trays because, according to Mr. Estey, they meet the requirements of uniformity, smoothness of surface, ruggedness, versatility and low cost. The price of a reinforced polyester tray is competitive after the initial mould cost has been written off. Another instance is that polyester tanks in the metal-finishing and electro-plating industries are replacing wood, steel or concrete tanks lined with lead, rubber or polyvinyl chloride. The cost of installation and maintenance of the latter types is high. The polyester tanks are light, easy to install and ready to use as soon as the tanks are in place.

At one plant, sulphuric acid mist and hot, moist sulphur dioxide waste flue gases were introduced into the mist stream in a mixing chamber. The stack, made of aluminium, developed leaks after three months. It was then wrapped with glass cloth and furane resin and held up satisfactorily for three years, with periodic repairs, before it cracked and had to be replaced. A reinforced polyester stack 36 in. in diameter was installed and, after a year of continuous operation, is giving complete satisfaction.

In a further example, a pilot-plant-size alum evaporator built nearly two years ago is still in excellent condition and is expected to give long service. The temperature reaches 240°F. during each 8-hr. cycle. For many years, alum evaporators have been constructed of steel, lined with a lead or mastic diaphragm and several courses of acid-proof brick. Although these steel tanks serve the intended purpose, the high cost of installation and maintenance makes the lightweight reinforced polyester alum tanks desirable.

The recent development of filter-press plates and frames represents another challenge to reinforced polyester fabricators. Although no manufacturer has gone into full-scale production of these items, several field trials are in progress, most of them involving 42-in. plates and frames moulded from pre-mix moulding compounds.

SOME RECENT INVESTIGATIONS INTO THE Design of Pressure Components

By P. H. R. Lane, B.SC.(ENG.)
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This article describes some investigations which have been carried out in recent years, with the object of increasing the knowledge of the stress systems in pressure vessels and piping components, thus providing a basis on which design methods may be made both more economical and more rational.

THE majority of the methods used in the design of pressure components today are based on many years' experience of vessels which have proved satisfactory in service, but they are not necessarily logical in their approach. It is not easy to test in service vessels designed on an experimental basis, since service vessels are usually required to be designed according to rules which have been proved over a number of years to give a safe product. It is therefore necessary to test vessels in the laboratory and, in general, it is desirable that the results of laboratory tests should be used to confirm theoretical calculations. If this can be done, it is then reasonable to base a design method on the calculations.

Laboratory tests can be divided into three groups. The first and simplest is that in which the specimen is subjected to gradually increasing load until failure occurs. With a pressure component, the loading would be hydraulic and failure would normally be defined as the bursting point of the component; if components subjected to external pressure were considered, then instead of a bursting point a collapse pressure would be observed. It might appear that such simple overload tests would give a reliable and absolute value for the true factor of safety, which is generally defined as the ratio between the working load and the maximum load which the component will sustain. While a bursting test will give a value for this factor as defined above, it is very rare in practice for a pressure component to fail by simple overload, and such tests must be supplemented by others.

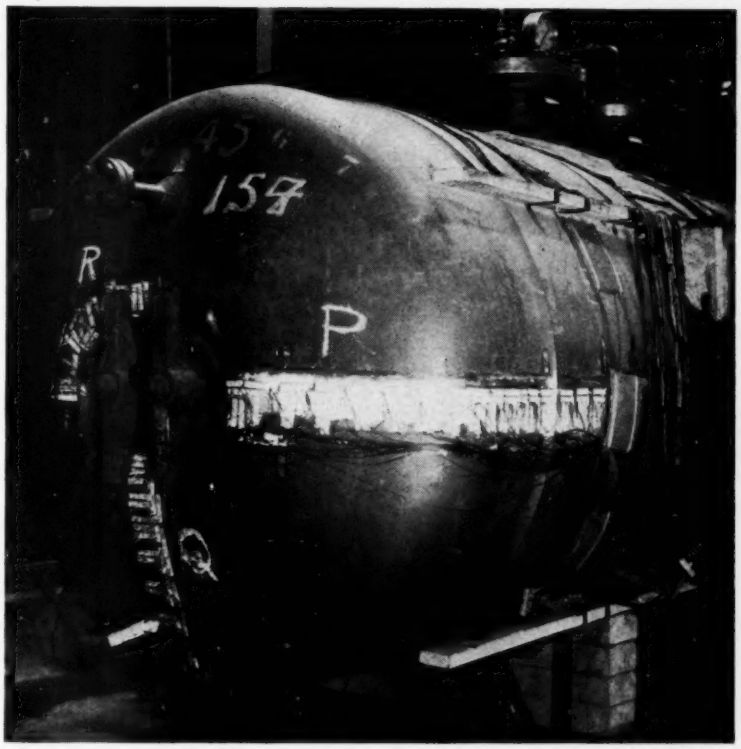

Fig. 1. First experimental pressure vessel referred to in the article, showing branches and strain gauges on outside of drumhead.

Fatigue testing

An inspection of some of the insurance companies' reports[1] on casualties suggests that when pressure vessels or boilers do fail they exhibit little ductility. For this reason it is possible to be misled by the simple bursting test, since the pressure and mode of failure in this test are apparently different from those found in the few service failures which occur. Failures more nearly like those found in service can be produced in a laboratory by subjecting the components to repeated applications of a pressure inferior to that required to burst the component. This is an application of fatigue testing which is well known to produce apparently brittle failures in normally ductile materials.

The fatigue method of testing pressure components is extremely sensitive and severe, since a fatigue crack may start in any small portion of the specimen which is subjected to a higher stress than the average. Once such a crack has started at a point of stress concentration, repeated yield at the apex of the crack on each load cycle allows the crack to propagate slowly until it penetrates the wall of the component.

By contrast, if a bursting test is carried out on a component which has an area of stress concentration, the material will yield there at a pressure considerably lower than the bursting pressure and the stresses will be redistributed, thus relieving the concentration.

While, as has been said above, very few service casualties are the result of simple bursting, it may be also argued that few vessels are subjected in service

to the drastic treatment which is given to them in a laboratory fatigue test. This is sufficiently true to indicate that for many cases it would be a mistake to attempt to relate the life obtained under laboratory fatigue conditions to the expected service life.

Nevertheless, the fatigue method may be extremely useful in comparing different designs. If different designs of component were placed in a given order of merit by means of laboratory fatigue tests, then the same order of merit would be expected in their service behaviour.

Experimental stress analysis

Experimental designs may be further examined using the techniques of stress analysis. Basic elastic theory allows the approximate calculation of the stresses at discontinuities in vessels and piping components, although in order to retain simplicity is is generally necessary to make further assumptions. Such calculations, based on assumptions which may or may not be justifiable, would be of little value unless it could be shown that the results were reasonably accurate. It is the purpose of experimental stress analysis to supply this confirmation. The techniques used will not be discussed here, beyond stating that most are related to measurements of changes in length of small portions of the specimen; the changes to be measured are of the order of 5 to 10 p.p.m. up to 1 part per thousand.

Much progress has been made since 1940, particularly towards measurements on inner surfaces of components subjected to internal pressure, where the largest stresses generally exist. Wire resistance strain gauges have been much used and enabled the inner surface measurements to be carried out for the first time. The pace of pressure vessel research has been much accelerated since the advent of the wire resistance gauge.

In 1946 and 1947 Babcock & Wilcox Ltd. carried out, on behalf of the British Welding Research Association, a comprehensive investigation of the stress systems in a typical power station boiler drum.[2] Fig. 1 gives a general view of one end of the drum. The nominally cylindrical shell was, as always, slightly out of true, although it was well within the limits allowed by the appropriate British Standard. The maximum radial deviation from a true mean circle was 0.92% and the difference between maximum and minimum diameters was 0.75%.

It was concluded that Haigh's[3] analysis of stresses due to out-of-

Fig. 2. Third experimental pressure vessel referred to, showing strain gauges on inside of shell near a branch with internal reinforcing plate.

circularity gave very good agreement with the stresses measured. Subsequent tests on other drums[4] have further confirmed this view.

This analysis shows that, when the departure from circularity is confined almost entirely to one location, the superimposed bending stress due to out-of-circularity is proportional to the ratio between the deviation from circularity and the thickness of the drum. Most current pressure vessel codes limit the permissible deviation from circularity by reference to the diameter of the drum, but on the basis of these tests it has been suggested that, if it proves difficult to adhere to the present limits for out-of-circularity, there is ample justification for relaxing the requirements as drum thicknesses increase.[5]

Stresses in drumheads

One of the drumheads of the experimental vessel described was plain and the other was provided with a standard flanged manhole. It was found that the stress systems in both these drumheads could be calculated with reasonable accuracy. Later work on drumheads containing manholes[6] has shown that, while flanged elliptical manholes are satisfactory for low and medium pressures, application of the same design rules to high-pressure vessels results in heads that are more flexible than is desirable. It has been suggested that this is due to the depth of the flanging around the manhole being related to the thickness of the head, resulting in the reinforcing material being further away from the hole for thick heads. To overcome this difficulty it has been proposed that all drum heads should be designed as plain heads and that where manholes have to be provided these should be compensated locally by the addition of extra material or otherwise.

Research on nozzles

Some measurements of stresses in and around welded-in nozzles were carried out during this early investigation, but it was thought desirable to carry out further and more comprehensive tests on this subject. Accordingly a special, full-size, experimental vessel was produced which contained three welded-in nozzles with equal bores and different thicknesses.[7] The purpose of this test was to determine whether it was practicable to reinforce vessel openings by making the nozzles thicker than required for their own resistance to pressure.

It was found by measurement and calculation that the thicknesses which would be necessary to provide adequate reinforcement were unreasonably large, so that other forms of reinforcement would be necessary.

The next stage of the investigation was therefore to measure the stress systems around nozzles which were provided with plate reinforcement.[8] The reinforcements examined were designed generally along the lines laid down by the appropriate British Standard[9] and strain measurements were made on inner and outer surfaces of the drum and the nozzles. Fig. 2 shows gauges around a branch with an internal reinforcing plate. The measurements showed that appreciable reinforcement was provided by external compensating plates of conventional shape, and further that, for a given cross-sectional area, height and width of the plate could be varied considerably without altering its effectiveness.

The tests also showed that, for a given cross-section of reinforcing plate, considerably greater reduction in stress could be obtained by placing it on the inside of the vessel rather than on the outside, and that the provision of two plates of half the former cross-section, one on the inside and one on the outside, provided the best type of reinforcement. As an interesting adjunct it was found that a nozzle which was allowed to protrude into the vessel provided as much reinforcement as an external compensating plate taking as a datum level an unreinforced nozzle flush on the inner surface.

Partial and full penetration welds for branches

Investigations into the stresses existing around nozzles reinforced in various ways can be carried out very conveniently by using stress analysis techniques coupled with static loading. Conversely, an investigation which was

concerned with the method of welding nozzles into drums could not be dealt with by static methods. In particular it was desirable to know the circumstances in which complete penetration welds were necessary when attaching a branch to a pressure vessel drum.[10] It may readily be seen that, if partial penetration welds are weaker than full penetration ones, the point of weakness would be expected to be at the roots of welds where it would be impossible to measure stresses with normal techniques. This type of problem lends itself to the use of fatigue testing.

Specimens were produced with branches attached, both with full and partial penetration welds, and for each type of weld two designs were investigated—one with the branch flush on the inside of the vessel and one with internal protrusion. These test specimens were subjected to pulsating internal pressure and a comparison of the different designs made on the basis of the number of cycles withstood before failure occurred.

Whilst only three specimens of each type were tested and the scatter of the results was fairly large, the tentative conclusion was drawn that, for the conditions of the tests, partial penetration welds were little inferior to full penetration ones, because the greatest stresses were along the welds, so that failure was not to any extent associated with the internal notch effect existing with partial penetration.

A similar investigation using pulsating internal pressure concerned the comparison of a number of shapes of end closures for pipes.[11] These tests were carried out on 6 in. × $\frac{3}{8}$ in. mild-steel pipes about 3-ft. long with the ends closed in the various ways. It was found that when flat ends were welded directly into the pipe the life was short, owing to the fact that the pipe was considerably more flexible than the disc welded to its end.

At each application of pressure large bending stresses were set up at the root of the attachment weld and failure ensued fairly rapidly. That this was the case was demonstrated by shrinking on a restraining ring close to the end plate (see Fig. 3). This ring had the effect of transferring the maximum bending stress (due to the flexing of the pipe) away from the root of the weld and also, by using a tapered ring, the bending was more effectively distributed. It was found that the application of this restraining ring increased the life fourfold.

The use of a ring for a similar purpose with jacketed vessels has been proposed previously.[12] Further tests were carried out on hemispherical ends and normal commercial torispherical ends. It was found that the lives of both these types were satisfactory except that, when a connection was welded into the end of the torispherical closures, the life was very considerably reduced—to about one-third of that of the unpierced end.

Pipe bend design

Turning now from components which might be described as pressure vessels to those which are essentially pipes, two recent investigations will be briefly discussed. The first of these concerned the design of pipe bends. Until recent years most bends in pipelines were designed with a bend radius approximately ten times or more the pipe radius. The methods of design which were used for these bends appeared to be quite satisfactory in that very few failures occurred. Occasionally, service fractures were found in which the crack ran along what would be the neutral axis in a curved bar loaded in the same way as the bend; such failures indicated that there must be in pipe bends rather different stress conditions from those existing in a solid bar similarly loaded.

This had been appreciated for some time and had been allowed for in the approximate design methods being used. Extensive service experience had shown that for the type of bend in use at that time, *i.e.* those with a large radius of curvature relative to the pipe radius, the approximations used were justifiable.

Owing to the increasing complexity of piping systems, the recent tendency has been to reduce the radius of curvature to a value much less than ten times the pipe radius, common present values being three times or even less. A comprehensive investigation into seamless pipe bends with small radii of curvature was therefore undertaken to determine whether the existing theory was satisfactory for bends of such proportions.[13] Wire resistance strain gauges were used to measure the stresses on both the inside and outside surfaces of pipe bends subjected to loads which would reduce the radius of curvature. The results of these measurements were compared with the approximate theoretical forecasts and it was found that serious discrepancies existed. Accordingly, the assumptions on which the theory was based were made more realistic at the expense of some additional complexity in calculation. When theoretical values were recalculated on the stricter basis, it was found possible to obtain good agreement with the stresses which had been measured.

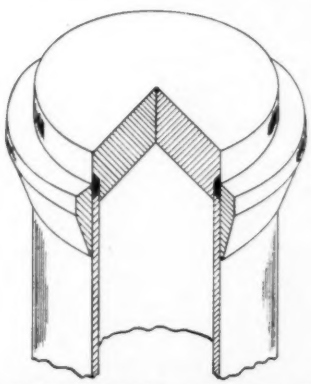

Fig. 3. Model header end closure with restraining ring.

Stress calculation for pipe bends

The method of calculating the stresses is based essentially on the setting up of expressions for displacements of elements of the wall of the bend, and similar calculations may therefore be used for estimating the flexibility of the bends. The opportunity was taken to compare the calculated flexibilities with those measured.[14] Many pipe bends are used as components of expansion joints of the 'U' or double-offset type and for these services the flexibility is as important as the stress distribution. It was also found that the revised theory forecast the flexibilities with reasonable accuracy.

On the basis of the theory, which had now been shown to be in good agreement with the facts, a revised design method has been proposed. The advantages claimed for this method as compared with the existing one are that, not only is it based on the more accurate theory, therefore giving useful results for a range of bends which could not previously be included, but also that it takes into account the fact that the greatest longitudinal stress in the bend does not occur at the same location as the greatest circumferential stress. The present design method consists essentially of obtaining longitudinal and circumferential stress intensification factors and combining these. In this way an over-conservative design is produced, since the real maximum combined stress is smaller than the value thus obtained.

When the bends are used as part of expansion joints, it is useful to be able to take maximum advantage of their inherent flexibility, and this is assisted by a method of determining

the minimum safe dimensions. When used as components of expansion joints, it is interesting to note that the small-radius bends are superior to their long-radius counterparts in that smaller stress intensification results from a given imposed angular movement.[15] It is doubtful whether this useful fact could have been established other than by such a combination of theoretical and experimental stress analysis.

The work described above was concerned solely with smooth, seamless bends; in practice, it is generally not possible to obtain such bends in pipe diameters above 18 in. When such sizes are required it is necessary to use fabricated bends in which the stress systems may be very different from those in corresponding smooth bends. Accordingly the investigation has now been extended to determine the stresses in bends fabricated from obliquely cut lengths of straight pipe.

This investigation has only recently been started, but the limited measurements available show that the stress conditions at the joint between two segments are not as severe as might be expected. It is hoped that when the investigation is completed it will provide a basis on which such fabricated bends may be confidently designed. One such bend is shown in the testing machine in Fig. 4.

Branch connections

Another subject which has received considerable attention is the strength and reinforcement of branch connections. In 1947 the results of a large number of tests on plain and reinforced branch connections were published.[16] The various connections had been subjected to internal pressure and measurements made of the pressure at which yielding first occurred and the maximum pressure withstood, prior to bursting.

Unreinforced branch connections with the branch perpendicular to the main were tested together with others with the branches at angles of 60° and 45° to the main. Some 'Y' pieces with 60° and 30° included angles were also tested. The types of reinforcement examined were shoes, straps and gussets, conventional reinforcement plates and the 'triform' reinforcement.

It was found that, as far as the pressure at yielding and at bursting was concerned, the triform reinforcement was superior to any other type examined; in fact, the results obtained from the triform could be considered as providing 100% reinforcement. In addition to the internal pressure tests, some static bending tests were made with loads in the plane of the specimen, together with others in which the specimens were subjected to repeated loading by means of a vibrator.

The conclusion drawn from these tests was that the triform type of reinforcement appeared to be completely effective for internal pressure conditions and provided the greatest possible reinforcement against all types of static loads and vibration in any direction.

Examination of branch reinforcements

Subsequent to this series of tests some further experiments were put in hand in which the stress distributions were measured in plain branch pieces with the branch perpendicular to the main and in similar reinforced specimens.[17] The stress distributions were measured under five conditions, each of which was intended to be representative of a type of loading which might be experienced in service. Loading systems used were axial loads on the branch with the main supported, bending of the branch in the plane of the specimen, bending in a plane perpendicular to that of the specimen, twisting the branch, and internal pressure.

Most of the specimens were tested under the various loading conditions separately, although it was appreciated that in service it would be most unlikely that a branch piece would be subjected to only one form of loading at a time. However, in this series of tests, the interest was in the elastic stress distributions, and it is a basic principle of elastic theory with small deformations that the stress distribution due to a combination of two forms of loading may be obtained by the simple summation of the stress components in corresponding directions due individually to each of the forms of loading.

It was demonstrated that this principle holds good with the types of branch piece examined by one test in which the specimen was subjected simultaneously to external load and to internal pressure.[18]

The reinforcements examined in this series of tests were, first, a thin collar attached to the main around the branch. The area of this collar on a longitudinal section represented about half the area of metal removed from the main. Secondly, a specimen with a thick collar was tested, the collar on this occasion representing about 10% more metal than was removed from the main. Thirdly, a specimen reinforced with a triform was used and, finally, one which had a thin collar and a girth strap, the major dimension of which was radial to the main. The tests showed that the triform reinforcement was the best of the types examined and gave a large measure of reinforcement, although the maximum stress could still be double that calculated for a similar straight pipe.

An interesting result was, however, that the light collar proved remarkably effective in reducing the stress concentrations. This work is proceeding with the examination of a specimen reinforced with a collar, whose area is equal to the area of metal cut out from the main, and another provided with a light collar and a girth strap, with its major dimension parallel to the main.

It is hoped in due course to supplement the static measurements with some fatigue tests. Some such tests carried out in the U.S.[19] show that, whereas the maximum measured stress is in the crotch of the tee, it is possible to obtain fatigue failures simultaneously at the crotch and on the plane at right-angles to this. The probable explanation is that the failure at the crotch is that associated with the measured stress, while that on the cheek is due to a highly localised concentration at the edge of the weld reinforcement.

Influence of yield-point stress

The magnitudes of the stresses found in experimental analyses, such as have been described, are frequently much higher than would be expected by experienced engineers who know that the designs have been proved to be safe by extensive use in service. It must be remembered that the high stresses and stress concentrations mentioned usually occur in very limited areas of the specimen. At present, most of the components described are constructed of mild steel which will yield and accept considerable local deformation without its strength being impaired. In this way the areas of high stress are usually relieved on first loading, and subsequent loadings cause no further damage provided certain conditions are fulfilled.

It is on this basis, and on the premise that the cause of many service failures of vessels is repeated reversed yielding, that it has been proposed that the yield-point stress should be used as a basis for design in preference to the ultimate strength which is used almost exclusively today.[20]

The line $H'C'OABF'Q'$ in Fig. 5 represents a stress strain curve for a

normal mild steel. *A* is the tensile yield point and *C'* the compressive yield point. Consider a portion of a vessel in which the theoretical elastic stress at service load is given by *SB'*. On first loading the strain will increase uniformly with stress until the point *A* is reached, when the material yields and the strain increases to the point *B*. At this point the total strain is the same as if the theoretical elastic stress *SB'* had been attainable. When the load is removed, the strain will decrease along the line *BC* which is parallel to *OA*. At *C* a compressive stress equal to the yield point in compression is reached and the material yields, the stress-strain curve following the line *CD* until the strain is again zero. On reloading, at the point *E* yield occurs, and the final position is represented by the point *F*. Subsequent loadings and unloadings will eventually bring the stress to the value indicated by *SQ*, which is considerably higher than would be inferred from a consideration of the stress-strain curve and the strain *OS* calculated from the theoretical elastic stress *SB'*. This stress *SQ* can, in fact, be greater than the rupture strength of the material and, when this is the case, a fracture showing little ductility can result from a relatively small number of load cycles.

A new basis for design

It can be seen that, if the theoretical elastic stress *SB'* is equal to or less than twice the yield-point stress, yield will occur on the first loading only and subsequent load cycles will produce only elastic stressing. This provides a justification for use of the yield stress as a basis for design, since prevention of reversed yield at the most highly stressed point would be a guarantee that rupture would not occur on repeated loading.

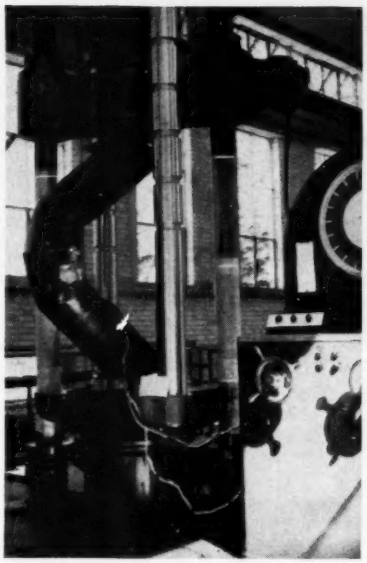

Fig. 4. A 12 in. × ⅜ in., three-weld gusseted head on test.

On this basis a rational method of incorporating calculated and measured stress concentrations factors is possible. Work carried out at Cambridge University[21] has shown that bending stresses may be allowed to exceed the yield point in uniaxial tension without yielding occurring. The actual stress at which yield takes place is dependent on the relation between the bending and direct stress. It has therefore been proposed that stress concentration factors should be divided into two portions and that the permissible bending stress concentration factor should be greater than the permissible direct stress concentration.

The above reasoning and proposed use of yield points is related to vessels constructed from mild steel which, as has been mentioned, are capable of yielding to a considerable degree without suffering any damage. If, as is probable with the trend towards higher pressures and larger-diameter vessels, the use of alloy steels becomes widespread, it may be necessary to reconsider such a basis of design, since alloy steels do not always have the same capacity for withstanding yield without damage as has mild steel.

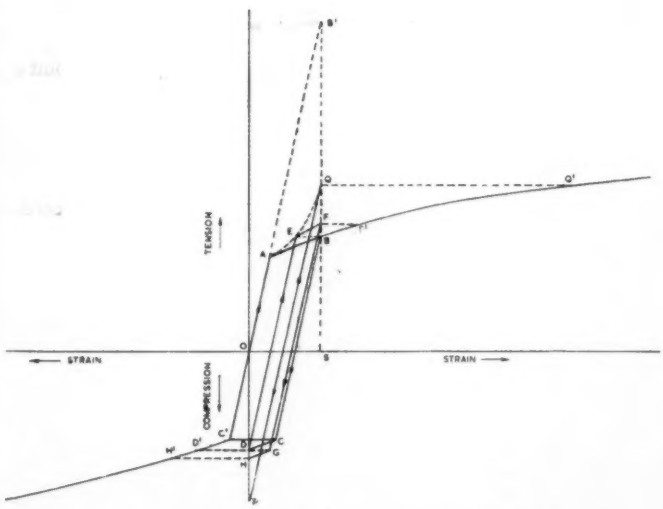

Fig. 5. Strain hardening due to repeated reversed yielding.

Acknowledgment

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CATALYSIS

Recent publications; semi-conducting oxides; vapour-phase oxidation of phenanthrene; silica-alumina catalysts; ion-exchange resins as catalysts

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THE main current emphasis of fundamental research on catalysts is on the influence of the electronic structure of the catalyst on its activity and selectivity. This particularly relates to the electron exchange processes which may possibly occur with one or more reactant on initial adsorption or which may accompany desorption of the products. Once the mechanism of the controlling step of a given reaction has been unravelled, it should become possible to predict the relative merits of various catalysts and to modify their electronic structures in any desired manner by suitable additives. It is perhaps true that, so far, the industry has not seen any technical revolutions in catalyst applications as a result of this newer fundamental approach. Hauffe[1] has suggested that the major technical advances will come from the development of reaction mechanisms not yet known, and in the development of catalyst selectivity so as to eliminate undesirable side reactions. He rightly emphasises the important contributions that may result from co-operation with chemists and physicists concerned with the development of semi-conductors for the electro-technical industries.

All the tools of modern science which may help in establishing clear pictures of the structures of the solids concerned and of adsorbed surface layers are being brought to bear on the general problem. One finds studies of adsorption and/or catalytic activity being carried out in conjunction with measurements of electrical conductivity (particularly surface conductivity), of magnetic properties, of contact potentials, of dielectric constants, or of the more formal structural properties such as *x*-ray or electron diffraction. The significance and potentialities of such studies may not be readily apparent to chemical engineers, but a number of suitable review articles have already appeared, and more may be expected as the results of these studies progress towards clarification of the overall problem.

Recent publications

Boudart[2] has compactly reviewed the literature on heterogeneous catalysis, giving 119 references, mainly to work in 1953. Useful reviews on adsorption[3] and on diffusion in and oxidation of metals[4] have appeared. Recent summaries on unit processes include reviews on catalysts for alkylation,[5] for decomposition of hydrocarbons,[6] for oxidation processes,[7] for polymerisation,[8] and a particularly useful literature summary of catalysts for various hydrogenation processes.[8a] The 11 papers presented at a recent symposium on the catalytic processing of gasoline fractions have been published.[9] These deal with the nine new catalytic reforming processes which have been disclosed since the last war, most of which use supported platinum catalysts operating in fixed beds under non-regenerative conditions. It is emphasised that a good hydroforming catalyst should have available both acidic and dehydrogenation sites, the interrelation of which appears to be very critical. The use of tungsten-nickel sulphide catalysts for hydrotreatment and desulphurisation is discussed in one paper, while another summarises research progress on the use of boron trifluoride to give products with improved storage stability. In a general survey on moving-bed processes for contacting solids and gases, Vener[10] surveys applications, present and potential, to catalytic reactions such as steam reforming of methane, oxidation of butenes and naphthalene, nitration of aromatics, olefin polymerisation and oxidation or reduction of sulphur dioxide.

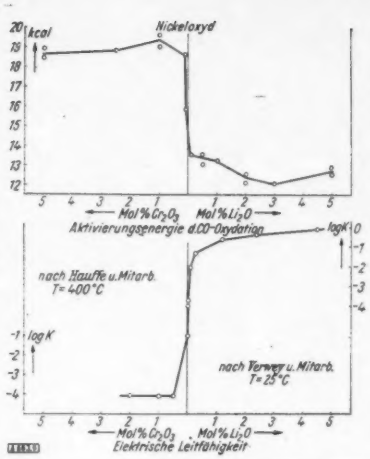
In 1952 an international symposium on the reactivity of solids was held at Gothenburg and the papers then presented were published[11] in 1954. Many of these have a direct bearing on catalysis, and many others an indirect one in the sense that they dealt with the surface properties of substances which are known to have useful catalytic activity. A number of the papers presented at a recent symposium on adsorption and catalysis held in France have been published—together with ensuing discussions—over the past 18 months.[12] Most of those given at a symposium in Canada on problems relating to the physical absorption of gases by solids have been issued in a single issue;[13] these were concerned with ' the state of physically adsorbed films, the structure and energetics of solid surfaces, and the theoretical aspects of adsorption phenomena.'

A recent publication on special materials[14] is stated to contain much useful information on substances used as catalysts. The latest issue[15] of 'Advances in Catalysis ' contains the usual authoritative articles with the range of interest we have come to expect. On the industrial side there is a survey of 180 pages on catalytic cracking, one of 43 pages on commercial isomerisation and a particularly useful review on the interpretations of measurements in experimental catalysis; two articles deal with catalyst types and the mechanism of their action—one with acidic and basic catalysts, and the other with noble metal catalysts for synthetic polymers; the two articles of a more fundamental nature cover catalysis and reaction kinetics at liquid interfaces, and some general aspects of chemisorption and catalysis mainly from the point of view of recent Japanese work.

The first two volumes of a projected series on catalysis have appeared.[16] According to the editor, the aim of this series is ' to attempt to record, in an orderly fashion, all that is now known in regard to the theory and practice of catalysis,' and this will be done through a series of articles by experts in particular fields, the first two volumes covering fundamental principles and theories, and successive volumes of unspecified number cover-

ing catalytic work on specific processes or types of processes. Volume 1 contains eight chapters — on physical adsorption, surface area measurements, chemisorption, kinetic laws in surface catalysis, absolute surface reaction rates, catalyst preparation, magnetism and catalysis, and on catalyst carriers, promoters, accelerators, poisons and inhibitors. The volume is characterised by a very clear presentation to which the many lengthy tables contribute. In Volume 2 there are chapters—again written by specialists—on homogeneous reactions in the liquid phase, on the theories of heterogeneous catalysis, on the nature of metallic and semi-conducting surfaces, on the nature of catalyst-substrate complexes, on reaction rates and selectivity, and on classes of heterogeneous vapour-phase catalytic reactions. A recent book on chemisorption by Trapnell[17] offers an excellent survey of current experimental techniques, results, and theories relating to adsorbed layers, and ends with discussions of their import to catalytic specificity and mechanisms of catalytic reactions.

Danziger[18] has reviewed the use of molybdenum catalysts as a contribution to a recent symposium in the U.S.A. on molybdenum chemistry. In 1953 some 200,000 lb. of molybdenum were consumed in catalyst manufacture compared with an estimate of 1,200,000 lb. for 1955 (world consumption). The manufacture of molybdenum catalysts, generally from ammonium molybdate as starting material, which with HCl gives the active trioxide or which can be used to impregnate carriers, is still considered an art and not a science. The versatility in catalytic processes, ranging from oxidation of alcohols through cyclisation and isomerisation to polymerisation, is due to the existence of a variety of compounds in various valency states capable of acting as electron donors or acceptors and showing good activity, selectivity, and resistance to poisons. However, consistency of valency state is important in maintaining selectivity; thus the trioxide with methyl alcohol and oxygen gives formaldehyde in 100% yield, whereas the dioxide gives carbon dioxide and water—it is therefore essential to have excess oxygen for the former process. Supports such as alumina may play a more vital part than simply acting as dispersion agents or in decreasing costs; for example, pure MoO_3 and pure Al_2O_3 have negligible activity for pentane isomerisation, whereas 10 to 20% MoO_3 on Al_2O_3-SiO_2 supports give 90% conversion to *iso*-pentene.



Figs. 1 and 2, courtesy: Angew. Chem.

Fig. 1. Effect on the activation energy for oxidation of CO of additives to NiO catalysts (Schwab[21]).

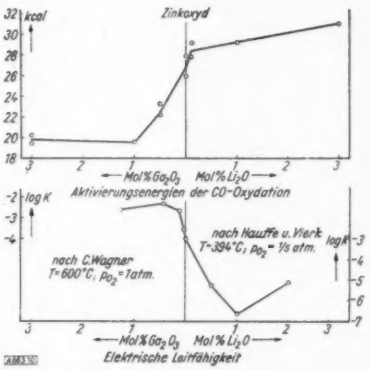


Fig. 2. Effect on activation energy for oxidation of CO of additives to ZnO catalysts (Schwab[21]).

In a somewhat different category are two recent books which concern the structure of solids of the semi-conducting type. The first, edited by Schottky,[19] deals with general problems of semi-conductors but contains material of definite relevance to the new approach in studies on catalysts of this type. In the second, a small monograph by Rees,[20] an attempt is made to classify the different kinds of defect solids according to basic types, and to relate these *inter alia* to the known catalytic properties. Hauffe[1] has presented an extensive review of the application of semi-conductor theory to problems of heterogeneous catalysis, in the course of which he also gives a notation for types of defects somewhat different from that of Rees. This has been somewhat extended in a more recent review paper by Schwab.[21] These three works have much in common. Rees brings out more adequately the possible influence of the 'mobility' of defects in surface layers. Hauffe and Schwab each deal more fully with the effect of additives which increase or decrease the electron-donating properties of oxides on the catalytic activity for simple reactions. This approach is based on Verwey's[22] 'controlled valency theory,' which predicts the effects of additions of cations of higher or lower valency on the electron conductivity of metallic oxides.

Semi-conducting oxides

Nickel oxide has a number of vacant cation sites, electrical neutrality being maintained effectively by the presence of Ni^{+++} ions—it is a 'positive hole' or p-type semi-conductor. Addition of monovalent Li ions at the nickel lattice positions increases the number of trivalent nickel ions and thus increases the conductivity. Similarly, addition of trivalent chromium ions decreases the conductivity. If the rate-controlling step in a catalytic reaction is adsorption of a gas molecule accompanied by donation of an electron from the molecule to the oxide, then the activity of nickel oxide should be increased by addition of lithium and decreased by addition of chromium. If the rate-controlling step is one in which the oxide donates an electron to the adsorbed molecule, then the reverse effects would be expected. A simple picture is provided by the following equations for the oxidation of carbon monoxide:

$$CO + Ni^{+++} \rightarrow (CO)^{+}_{adsd} + Ni^{++} \quad \ldots\ldots\ldots\ldots (a)$$

$$(CO)^{+}_{adsd} + Ni^{++} + \tfrac{1}{2}O_2 \rightarrow CO_2 + Ni^{+++} \quad \ldots\ldots\ldots\ldots (b)$$

From Fig. 1 it is seen that the activation energy for the oxidation (calculated from the temperature variation of the velocity constant) is decreased by the addition of small percentages of Li_2O and increased markedly by addition of small percentages of Cr_2O_3, suggesting that the rate-controlling step is the chemisorption of carbon monoxide according to (*a*). The subsequent increase with higher percentages of Li_2O_3 suggests that the chemisorption of oxygen then becomes energetically unfavourable and is therefore partially rate controlling.

On the other hand, zinc oxide contains an excess of zinc incorporated either as atoms or monovalent ions, electrical neutrality being preserved by the presence of 'free' electrons—it is an electron excess or n-type conductor. Addition of monovalent

ions such as lithium reduces its conductivity, while that of trivalent ions such as gallium increases it. Schwab[21] has shown that in these two cases the activation energy for carbon monoxide oxidation is respectively increased and decreased (Fig. 2). This implies that the rate-controlling step with oxides of this type is a process involving donation of electrons from the oxide to an adsorbate molecule:

$$Zn + \tfrac{1}{2}O_2 \rightarrow ZnO \text{ (slow)}$$
$$ZnO + CO \rightarrow Zn + CO_2 \text{ (fast, centres regenerated)}$$

Hauffe and co-workers[1] have demonstrated similar effects for the decomposition of nitrous oxide over nickel oxide catalysts. Additions of *small* amounts of lithium increase the activity; those of indium decrease it. Schwab and Block find that additions of lithium to zinc oxide decrease the activation energy; those of gallium increase it. These results indicate that the rate-controlling step is the desorption of chemisorbed oxygen:

p-type oxides

$$N_2O + Ni^{++} \rightarrow N_2 + (O)^-_{adsd} + Ni^{+++} \text{ (fast)}$$
$$2(O)^-_{adsd} + 2Ni^{+++} \rightarrow O_2 + 2Ni^{++} \text{ (slow)}$$

Thus increases in Ni^{+++} concentration will increase the rate unless the concentration becomes so high that it slows down the initial chemisorption.

n-type oxides

$$N_2O + e \rightarrow N_2 + (O)^-_{adsd} \text{ (fast)}$$
$$2(O)^-_{adsd} \rightarrow O_2 + 2e. \text{ (slow)}$$

Thus decreases in the excess electron concentration will increase the rate by making the forward slow reaction more favourable, unless the concentration of electrons becomes so low that the initial chemisorption is slowed down.

Vapour-phase oxidation of phenanthrene

Large amounts of phenanthrene are potentially available in creosote and anthracene oils, but, despite its possible use in the manufacture of intermediates for alkyd resins and plasticisers, this source has not so far been fully exploited. Brooks[24] has described a laboratory-scale converter using fluidised catalysts, which obviates excessive oxidation to phthalic anhydride because of the large heat of reaction and, with suitable catalysts, gives reasonable yields of products of relatively high molecular weight. This is shown in Fig. 3. Air containing phenanthrene vapour was passed vertically upward through a catalyst bed 0.5 to 10 cm. deep at a rate sufficient to maintain a fluidised state when uniform bed temperatures resulted.

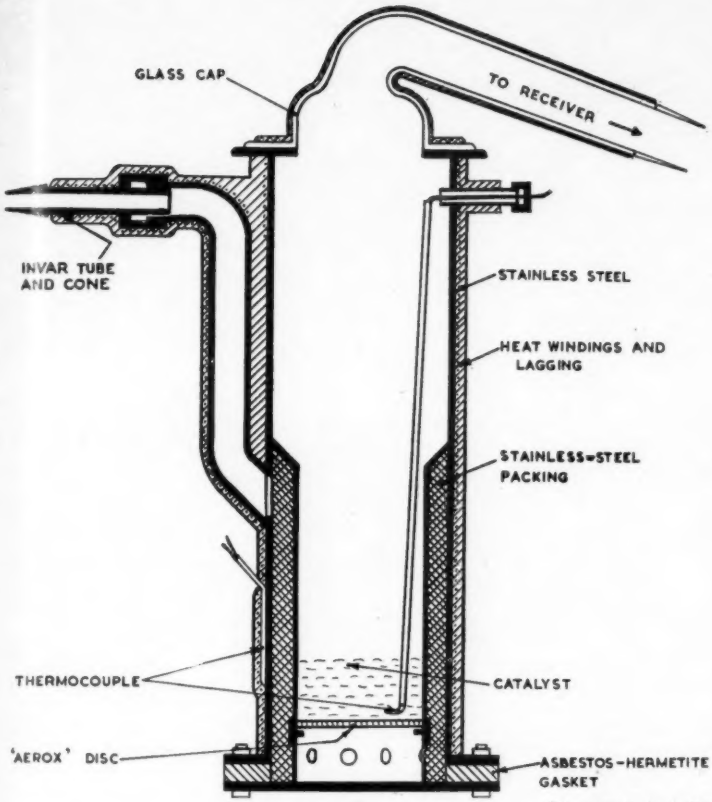
A variety of oxide catalysts, supported silver and copper powder were inactive or gave almost complete conversion to gaseous products. Vanadium pentoxide on silica supports proved most suitable; 25% coated on silica micro-spheres or impregnated into silica gel from the sulphate solution, followed by ignition, gave maleic and phthalic anhydrides as the only non-gaseous products; 56% phthalic anhydride could be obtained at 450°C. with oxygen: phenanthrene 47: 1 and contact time 9 sec., but it was difficult to maintain steady conditions at lower temperatures with these catalysts. Using silica microspheres impregnated in fused V_2O_5/K_2SO_4 mixture to give a ratio of 12.5: 3.5: 1 for SiO_2: K_2SO_4: V_2O_5, good control could be obtained at as low as 340°C. with much lower yields of gaseous products and a high proportion of products with molecular weight above that of phthalic anhydride. With an oxygen: vapour ratio of 48: 1 and contact time of 1 sec., 45% of a diphenyl lactone was obtained at 370°C., and 18% of 1: 2 naphthalic anhydride at 375°C. It appears that the phenanthrene is attacked preferentially at the 9 : 10 position to give 2-hydroxy diphenyl 2′ carboxylic acid lactone and fluorenone, further oxidation of which gives phthalic and maleic anhydrides. Increase of the oxygen: vapour ratio appears to favour attack in the 1: 2 position, however, and it is reported that other workers have obtained 80% yields of the resulting compound 1: 2 naphthalic anhydride.

Silica-alumina catalysts

Since the last review[25] on these 'acidic' type of catalysts, widely used for catalytic cracking and isomerisation, a considerable amount of work has been carried out with a view to determining the structure and the mode of action of the catalysts. Effort has been concentrated on the silica-alumina catalysts with Si: Al in atomic ratio 1 to 2: 1, which are industrially the most active. (It has been estimated[26] that annual consumptions in 1955 should be of the order 200,000 tons of the fluidised type and 70,000 tons of the pelleted type of catalyst.) The views of Thomas (presented in the last review) that the catalysts were solid acids containing protons and thus of the Brönsted type have been challenged, at least for the calcined catalysts. While there continues to be general agreement that reactions over these catalysts involve a carbonium ion mechanism, there is still rivalry in opinion as to whether this occurs through donation of a proton from a Brönsted acid to the reactant or acceptance of an electron from the reactant by a Lewis acid.

Clark[27] has indicated that the activity of these catalysts for the polymerisation of propylene can be considerably increased by impregnating dried gels (90 wt.% silica) with oxides (4 wt.%) of metals of Groups V to VIII, followed by ignition in air at 500°C. Similar impregnation with oxides of the metals of Groups I to IV considerably lower or retard the activity. The activity of the first class of complexes is reduced below that of silica-alumina on pretreatment in hydrogen at 500°C., while that of the second class is unaffected. Strongly electron-donating substances such as benzene, hydrogen sulphide or carbon monoxide decrease the activity of the first class. If these oxides are supported on substances such as activated carbon they show no appreciable increase in activity over the pure oxides, and Clark interprets this as indicative of the need for residual water in the supports to act as a source of protons. The increased activity was not due to an increase in surface area of the silica-alumina gel, but there was some indication of a correlation with an increase in acidity as gauged by butylamine titration. Clark suggests that some of the oxides might act in certain valency states as good electron acceptors, thus increasing the amount and strength of acidity of the catalyst surface.

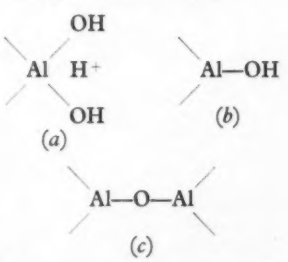
The work of Danforth[28] on the effect of alkali metals on the activity of catalysts for cetane cracking indicates that the radius, rather than the charge, on the impurity ion is the factor with which poisoning increases; thus the barium and potassium ions of similar radii have similar poisoning effects. Danforth suggests that a measure of the number of active sites can be obtained from the mequivalents of Li necessary to poison the catalyst, and that the activity of the catalyst may be due to the condensation of polymeric alumina chains on the silica micelle. According to Appell and Berger,[6] McIntosh has also demonstrated that oxides of Pb, Sn, Ti, Na and K, as well as Mn of Group VII, lower the activity but not the selectivity of cracking catalysts, and that oxides of Fe, Ni and V reduce the selectivity.



[Courtesy: J. Appl. Chem.

Fig. 3. Catalytic converter used in laboratory-scale oxidation of phenanthrene (Brooks[24]).

Mapes and Eischens,[30] from a study of the infra-red absorption spectra of ammonia chemisorbed on calcined silica-alumina catalysts, conclude that most is bound as ammonia and very little as the ammonium ion, whereas bands of the ammonium ion develop on rehydration. This suggests the existence of Lewis acid centres with some Brönsted acid ones. Oblad and co-workers[31, 32] have shown that 50 to 100% of the oxygen in these catalysts undergoes rapid exchange with O^{18} from enriched water at catalyst cracking temperatures, and that from deuterated catalysts (with heavy water) there is a rapid exchange of deuterium with the hydrogen of C^5 to C^8 hydrocarbons containing tertiary carbon atoms. They have also demonstrated the strong effect of traces of water as low as 0.05% on the isomerisation of 2-methyl pentane at 150°C. (increase from 1 to 21%). Danforth[29] has suggested a structure for these catalysts which is in keeping with the above and many other observations. This was arrived at from a study of the acidity developed when methylethoxysilanes with from 1 to 3 ethoxy groups were condensed with aluminium isopropoxide. With one ethoxy group there was no condensation; with two and three such groups Si: Al ratios of 5: 1 and 3: 1 respectively were indicated. In cracking catalysts made from tetraethoxysilane there is maximum acidity at a ratio of 2: 1. The structure suggested is a hexagonal network containing —Si—O—Si—, —Si—O—Al— bridges in which all Si atoms are four-co-ordinated, but the Al atoms may be three- or four-co-ordinated depending on the degree of calcination:



Thus a given catalyst may contain varying proportions of the three types of aluminium terminations, of which (*b*) is believed to be the catalytically active one—both as a Brönsted acid by virtue of its proton and as a Lewis acid by virtue of its ability to revert to four-co-ordination, for example, by reaction with water or hydrocarbons.

Ion-exchange resins as catalysts

Mineral ion-exchangers have been known for some time and were shown some 38 years ago to be catalytically active for reactions such as the inversion of cane sugar. However, it is only within the last decade since the development of synthetic resin exchangers that any serious attention has been paid to the use of ion exchangers in liquid-phase acid-base catalysis. Hefferich[33] states that systematic investigations on the use of ion exchangers was actually carried out in Germany much earlier, but the results were not made known until 1942 to 1944 when patents were taken out.

Broadly speaking, an ion-exchange resin consists of a network of acidic (sulphonic or carboxylic) or basic (trimethylammonium) groups firmly anchored in a cross-linked polymer with resultant pores in which the compensating cations or anions, respectively, are present in a fairly mobile condition, resulting in a cation or anion exchanger—acid or base when the ions are hydrogen and hydroxyl, respectively. When placed in a solution (solvent), solutes and ions are present within the pores in fairly intimate contact. To be of value, the pores must contain the particular catalytically active ion and be large enough to accommodate the reactant solute molecule. This allows some possibility of selectivity according to size in a mixture of reactants. The product diffuses out into the main solution fairly rapidly, provided it is soluble in the solvent used, and thus side reactions may be curtailed. The catalyst can be easily filtered off, washed and re-used, and the process may even be made continuous. A further advantage with acid catalysis is the non-corrosive nature of the mix. However, a deterrent to large-scale use is the relatively high cost of the resins compared to mineral acids or alkalis.

The work of Davis and Thomas[34] and of Hammett and associates[35, 36, 37] on ester hydrolysis emphasises the importance of exchanger structure, solvent distribution (especially with mixed solvents) and solute distribution between solution within and outside the exchanger. Thomas found Wofatit (4 mequiv. carboxylic groups per gramme) at times less effective than *Amberlite* 1 R 100 (2 mequiv. sulphonic groups per gramme), and both more

effective than equivalent amounts of HCl, especially for higher molecular weight esters—all in aqueous solution. On the other hand, Bernhard and Hammett found cross-linked polystyrene sulphonic acid resin to be less efficient than HCl in 70% aqueous acetone, and less so the longer the chain length of the ester; in aqueous solution lightly cross-linked resins were more, and highly cross-linked ones less, effective than HCl. Hammett attributes the effect of increased cross linking to a reduction of the quantity of solvent which the resin can retain. In support of this, partial replacement of the hydrogen ions by polyvalent ions such as Mg^{++} or $(CH_3)_3N^+CH_2CH_2N^+(CH_3)_3$ showed definite effects which were specific, depending on the nature of the ester and the replacing ion. In the latest paper it was shown that replacement of 70% H-ions by cetyl trimethyl ammonium ion had a specifically favourable effect on the activity of the remaining H-ions for the hydrolysis of n-hexanoate, and by methyl tribenzyl ammonium ion for hydrolysis of methyl phenol acetate (cross-linked polystyrene sulphonic acid resins in 70% acetone). Thus the increasing incorporation in a resin of long-chain aliphatics or of aromatics lowers the standard free energy of the transition state for hydrolyses of esters containing similar structures relative to those for other esters.

Austerweil and Polland[38] have shown that strongly basic anion exchangers such as *Dowex* 1, *Amberlite* 400 or *Alassion AW* catalyse the condensation of aldehydes to aldols according to equation type (*a*) for C_4 and lower, followed by type (*b*) for higher aldehydes, especially if products are sparingly water soluble:

(*a*) $CH_2R'.CHO + CH_2R''.CHO \rightarrow CH_2R'.CH(OH).CHR''.CHO$

(*b*) $CH_2R'CH(OH)CHR''.CHO \rightarrow CH_2R'.CH{:}\,CR''.CHO + H_2O$

The exchanger is simply added to an aqueous-alcoholic solution of the two reactants and after two to three days at room temperature or up to 50°C. the suspended product is decanted off, filtered, and unchanged liquid recycled on new batches of exchanger. Advantages over classical condensations are the almost total absence of by-products, the use of low temperatures and the ready separation of products.

Hefferich[33] has given comprehensive tables with references classifying types of reactions in which ion exchangers have been used. Amongst those in which high yields are reported are hydrolysis of peptides and proteins, condensation of acids and esters in more than 90% yield on a technical scale, 90% acetal formation from formaldehyde and butanol, 68% yield of diacetone alcohol from acetone with an anion exchanger, 88% yield of 1, 2, 4 trichlorbenzene from hexachlorcyclohexane with anion exchanger, and 70% yields and better of propargylalcohol using Hg-ions on *Dowex* 50.

Although admitting that available data is unsuitable for exact theoretical treatment (largely because of unknown variations in resins used by different workers and of insufficiently specified conditions), Hefferich has indicated a quantitative approach to the interpretation of ion-exchange catalysis. The pore liquid in the resin, in which the reaction occurs, is considered as a homogeneous system with a specific catalytic ion concentration, and compared with the case of a homogeneous solution containing a dissolved electrolyte as catalyst. The rate-determining step may then be either the velocity of the reaction itself or the diffusion processes within the resin. A comparison of the rate constants and energies of activation for systems with and without resin will show up any special influence of the resin, other than adsorption phenomena, which can be assessed separately.

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Du Pont's Increased Operating Investment

Last year, E. I. Du Pont de Nemours & Co. put $119 million into new plants, expansion at existing plants, and service and laboratory facilities, including projects for neoprene synthetic rubber, tetraethyl lead, *Orlon* acrylic yarn and staple, nylon, *Cellophane* and other products. Four new plants are under construction: one at Tucker, Georgia, near Atlanta, for finishes; one near Cincinnati, Ohio, for sulphuric acid; one at Montague, Michigan, for neoprene; and one at Antioch, California, for tetraethyl lead and *Freon* refrigerants. A large integrated unit, to produce sodium, ethyl chloride and other products, is being designed for construction at Antioch.

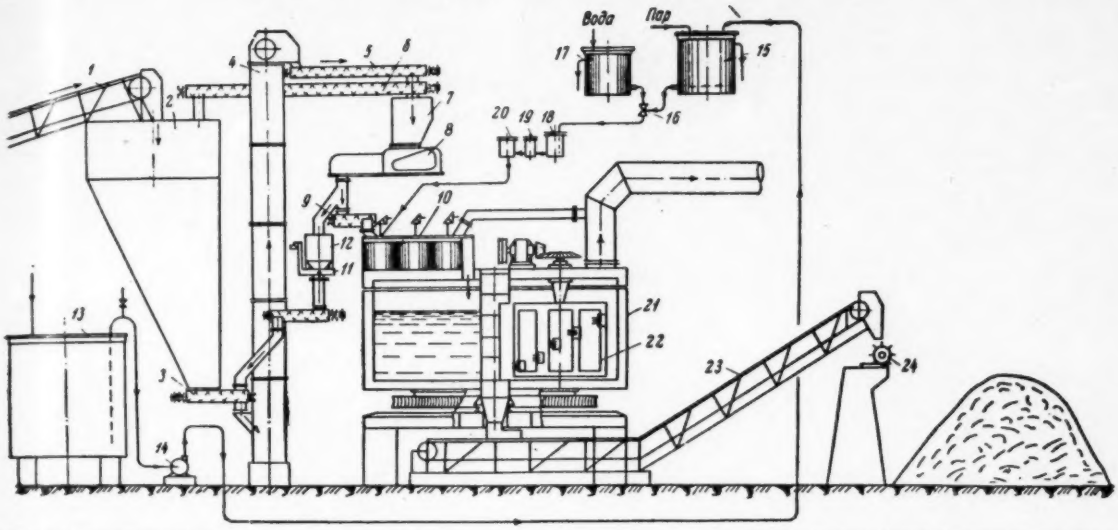
This is revealed in the annual report of the company, which includes a 10-year post-war progress review. Since 1946, operating investment, reflecting additional productive capacity, increased 137% from $892 million to $2,112 million, an annual growth rate of 10%.

The sales in 1955—$1,909 million—were 194% above the $694 million of 1946. This indicates an annual growth rate of 13%.

A substantial section of the report is devoted to the company's engineering activities. The company's engineering department has undertaken about 1,500 projects in the past 10 years, accounting for more than $800 million of the company's expansion and improvement programme over the period. In addition, it has handled projects aggregating $1,300 million for the Government and two Du Pont licensees.

Superphosphate Manufacture in Russia

Efforts to Improve Continuous Process



General arrangement, plant for superphosphate manufacture by continuous process (key to numbered components in text)

PRECISE information on certain aspects of superphosphate manufacture in the Soviet Union, such as the volume of total production, is difficult to obtain. However, the level of technical practice that has been attained in that important branch of industry in Russia can be gauged from published reports. In particular, a detailed illustrated report by D. L. Tsȳrlin, which has appeared in *Zhurn Prikladn.Khim*, 1955, **28** (10), 1025-1036, reveals some interesting facts about progress in the use of the continuous process, while the semi-continuous method is also described, together with the manufacture of the granular form which at present constitutes about 45% of the total (and in 1958 is expected to reach 60%.)

This report emphasises the importance of the continuous process and discusses its advantages, which include:
(a) an almost complete elimination of the dust and vapour nuisance,
(b) greater labour efficiency and improved product,
(c) the use of acid of higher concentration, thus lowering moisture content with corresponding increase in phosphoric acid content in an assimilable form.

Reduction of moisture in the continuous process by about 1% raises assimilable P_2O_5 by 0.22%. However, in manufacturing from apatite concentrate—the chief raw material used in Russia—in the batch or periodic mixing of reagents, the use of sulphuric stronger than 64% is not possible owing to weakening of apatite dissociation by the acid and formation of a dense film of calcium sulphate on the apatite granules. Too high a temperature may act in the same way. The conditions are more favourable in the continuous method and acid up to 68½% may be used. Some analyses are given in the accompanying table.

Process		Total	Content % Assim.	P_2O_5 Free	Water	Acid, kg. per 100 kg apatite	Assim. ratio or coeff.
Chamber	Batch (period)	19.9	16.7	11.9	14.5	70.6	83.9
	Continuous	20.7	17.8	12.2	12.7	69.8	86.0
Despatch (Russ Expeditionary)	Batch	20.5	18.9	5.1	12.7	70.6	92.0
	Continuous	21.5	20.2	5.0	9.8	69.8	94.0

Attempts have been made lately in the Soviet Union to improve and intensify the continuous method, and to introduce still more automation, thus raising rotary chamber capacity from 20 to 50 tons/hr. At present the operations of mixing or syrup-formation, temperature control, and weighing in of sulphuric acid and apatite are wholly automatic.

Description of plant

In the plant (see diagram), apatite or phosphorite flour is conveyed by transporter, (1) to a bunker, (2) through worm feed, (3) to bucket elevator and so into another worm conveyor, (5) (forward) thence by return conveyor (6) into the bunker (7) of the weigher or measuring hopper (8). Excess is returned to (2) via (6). A constant feed level is thus maintained. Measured material passes through to the superphosphate mixer, with exclusion of gases or vapours from the measuring hopper. The measured feed is checked by balances associated with a further bunker.

At the same time, 75% acid is fed to tank (13) and thence by a centrifugal pump (14) into a pressure tank (15) of constant level, with excess passing back to the tank. If necessary, open steam heating is available in the pressure tank, the acid passes to an acid mixer where it is diluted to a concentration of 67 to 68%, with water from a pressure tank kept at constant level. The acid goes to a gas separator for removal of nitrogen oxides, etc., and to the acid strength gauge; then to a consumption gauge and finally a mixer. The gauges mentioned work on the piezometric principle, and there is automatic control of temperature, acid concentration and feed, with record.

The reaction product now proceeds

to the superphosphate rotary chamber where it partly sets or cakes and is broken up by a cutter. Thence it is carried by a belt conveyor to the spreader for storage in heaps cooled by intensive evaporation of moisture therefrom and at the same time finely disintegrated. Cranes, etc., are provided for loading into rail wagons.

Gases forming at various points are removed by exhaust and fluorine recovered, from which sodium silicofluoride is obtained by conversion from the corresponding acid.

Rotary chamber and mixer

Further details are given of the rotary drum or chamber and of the mixer. The former consists essentially of a ferro-concrete cylinder, steel-jacketed, of 7.1 m. diam. and 2½m. high, mounted on 16 roller supports. It rotates (once in 2½ hr.) about a hollow cast iron tube of 1.06 m. dia., driven by a motor of 4½ kw. through reductor and worm gearing. It is covered by a stationary ferro-concrete roof. Sealing between the bottom of the drum and the cast iron pipe is by packing glands or the like, and between cylindrical walls and the roof is sheet rubber. A cast iron partition divides the loading from the cutter zone. It is suspended from the roof and also fastened to the central tube. Sheet steel is here used for packing. The cutter turns in the opposite direction to that of drum at 8 to 10 r.p.m. As protection against corrosive action the inside is lined with diabase on sodium silicate. The capacity of such a plant is about 30 tons/hr. of superphosphate, but by increasing the speed of rotation to one turn in 1½ hr. output can be raised to 50 tons/hr.

The mixer comprises a welded steel body or frame, lined with acid-resistant brick, and provided with three or four vertical stirrers. That of the Vinnitsk superphosphate works has four stirrers. The two front stirrers rotate at 150 r.p.m. (5½ m./sec peripheral), and the two following at 120 r.p.m. Preparation of the mix when using apatite takes about 6 min. Processing time is controlled by means of a cast iron gate or slide valve adjusted at the required height. The mixer is lined with diabase as anti-corrosive. For better adhesion this is laid over a metal net or grid. Yet the stirrers do not last for more than a month or two before renewal or reconditioning, and an urgent task to-day is the search for better and more acid-resistant material for the stirrers.

The measuring device (dosator) for the phosphate meal, comprises a belt conveyor running on two drums and contacting a balancing roller which, in turn, is associated with a system of levers and balance arm. The weight of the operative part of belt with its load of meal bears on the roller and thus on the balance arm and equalising weight. The meal passes from the supply bunker through a gate valve, hand-controlled, whereby the height of the load is regulated. In normal working the balance arm oscillates smoothly about its mean position. Width of conveyor belt is 0.65 m, speed of travel 10 to 15m/min and capacity of measuring unit 10 to 25 tons/hr.

The lump-breaker consists of a rotating horizontal steel drum or cylinder, 0.6 m. long and 0.5 m.diam, carrying ten steel ribs or fins 30 mm. high, and directly coupled to a 16½-kw. motor, whereby it rotates at 960 r.p.m. Distance of scatter is controlled by adjusting angle of slope of the table disposed above at the mouth of the shoot. The maximum is 20 m. Material is fed to the breaker at a temperature of about 80°C. During the flow of the material part of its moisture evaporates so that it is cooled down to 30 to 40°. At the same time the lumps that, to a greater or less extent, always form, are broken up.

Decline in batch production

The semi-continuous method of production, for a capacity up to 100 tons/hr. of superphosphate, and yielding somewhat higher content of total and assimilable P_2O_5, has been briefly described by Tsȳrlin. Acid concentration should not exceed 67% H_2SO_4. In 1955 the respective figures for continuous, semi-continuous and batch production were 30%, 45% and 25%, showing considerable increase in the first two, and reduction in the third. A new source of raw material has lately been tried, the Kara-Tau phosphorites, but their 4% content (average) of mono-magnesium phosphate creates difficulties. The best, perhaps the only, way of using them is by the granulation or ammoniation process. The latter process has been little tried so far in the Soviet Union.

Suggestions made for the further development of the industry in Russia include complete conversion of all manufacture to the continuous process; more mechanisation and automation; greater use of the Kara-Tau material under the right conditions, with new methods as well as ammoniation; increased recovery and use of fluorine and compounds; and the use of hydrochloric mother liquor for the manufacture of sodium fluo-silicate.

British Standards

Vertical welded storage tanks (B.S. 2654: 1956, 15s., ' Vertical mild-steel welded storage tanks with butt-welded shells for the petroleum industry. Part 1: Design and fabrication.'). This new standard specifies the materials, design and fabrication of vertical cylindrical tanks, with butt-welded shells, for erection above ground. The tanks are of the following types: (*a*) Non-pressure fixed roof tanks (all sizes); (*b*) pressure-fixed roof tanks (up to 128-ft. diameter only); and (*c*) open-top tanks (all sizes). Tanks with floating roofs are excluded. Reference is made to mountings, stairways and handrailings.

Electroplating materials (B.S. 2656, ' Zinc anodes, zinc cyanide and zinc oxide for electroplating '; B.S. 2657, ' Fluoroboric acid and metallic fluoborates for electroplating '; 4s. each). B.S. 2656 specifies requirements for zinc anodes which are specifically of the purity of high-purity zinc in accordance with B.S. 1003/4 (' High-purity zinc and zinc alloys for die casting '). The standard lays down maximum impurities for zinc cyanides, zinc oxide and zinc anodes. Methods of test are also specified. B.S. 2657 specifies requirements for two grades of fluoroboric acid and for solutions of lead fluoroborate, tin fluoroborate and copper fluoroborate.

Wrought aluminium and aluminium alloys (B.S. 1470: 1955, 7s. 6d.; B.S. 1471-77: 1955, 6s. each). Revised editions of this series of standards, which were first issued between 1948 and 1951, deal with various wrought forms as follows: B.S. 1470, sheet and strip; B.S. 1471, drawn tube; B.S. 1472, forgings and forging stock; B.S. 1473, rivet, bolt and screw stock for forging; B.S. 1474, extruded round tube and hollow sections; B.S. 1475, wire; B.S. 1476, bars, rods and sections; B.S. 1477, plate.

Unified fasteners (B.S. 2708: 1956, 5s. net, ' Unified black square and hexagon bolts, screws, nuts (UNC and UNF threads) and plain washers —normal series '). Standards for the normal precision and heavy black series have now been established for some time and it has long been apparent that there was a need for this complementary standard, which includes appendices giving formulae for the calculation of sizes outside the range of the specification, details of identification marking, and tables of approximate weights of bolts and nuts.

Graphical Design Calculations for EXTRACTION WITH REFLUX

By S. R. M. Ellis, PH.D., F.R.I.C., A.M.I.CHEM.E.

(Department of Chemical Engineering, University of Birmingham)

A special form of the Ponchon and Savarit construction is proposed for calculating the number of stages in reflux liquid extraction operations. Reflux concentration diagrams clearly show the variation in reflux throughout the column and these diagrams have the advantage over mass or mol ratio diagrams in that they are suitable for most counter-current unit operations as in distillation, absorption, liquid-liquid extraction, leaching, etc.

LIQUID-LIQUID extraction operations using two binary immiscible systems with reflux are important in the separation of hydrocarbon mixtures, as for example the use of aniline in the separation of n-hexane from methylcyclopentane, or methylcyclohexane from n-heptane.

The use of triangular graph constructions in the determination of the number of equilibrium stages is difficult because the operating lines are close together at the low concentration of components in the solvent or extract phase. This limitation is clearly seen in the example of Brown[1] in the separation with reflux of n-hexane from methylcyclopentane with aniline.

On the other hand, arithmetical stage-to-stage calculations made on a solvent or solvent-free basis are tedious and time-consuming; furthermore, for stagewise calculations on a solvent basis, great accuracy is required in the arithmetical calculations.

The Ponchon and Savarit graphical construction has been used for reflux liquid extraction calculations on a mass or volume ratio diagram.[2, 3] By expressing the composition changes on a solvent-free basis, accurate determinations can be simply and rapidly made of the number of equilibrium stages.

The use is now suggested of a Ponchon and Savarit construction with a reflux-concentration diagram. One advantage for this reflux-concentration diagram is that the variation in reflux ratio throughout the column is readily interpreted and is in a form suitable for most unit operations such as distillation,[4] gas absorption,[5] liquid-liquid extraction, etc.

The following example is used to illustrate the method. The separation is required of a mixture of methylcyclopentane and n-hexane containing 0.4 mol. fraction methylcyclopentane

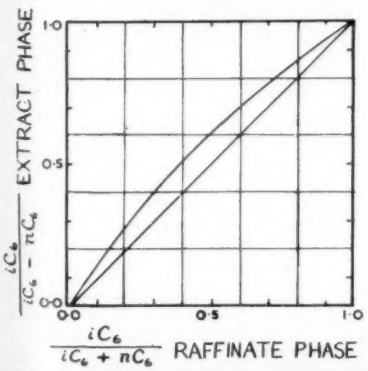


Fig. 1. Equilibrium data (iC_6 = methylcyclopentane, nC_6 = n-hexane).

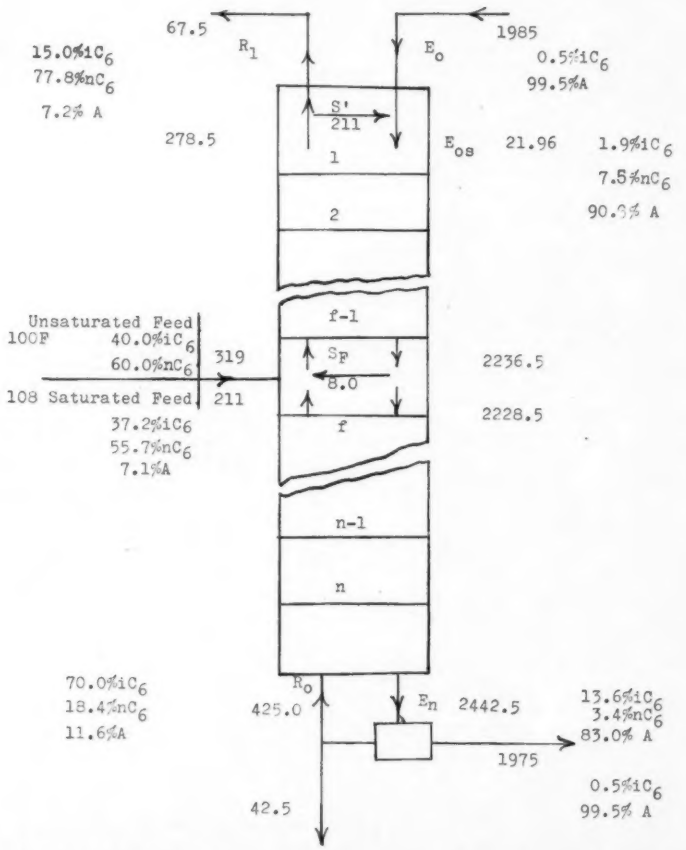


Fig. 2. Material balance (iC_6 = methylcyclopentane, nC_6 = n-hexane, A = aniline).

and 0.6 mol. fraction n-hexane. The extraction is made at 25°C. with solvent of composition 0.995 mol. fraction aniline and 0.005 mol. fraction methylcyclopentane. The raffinate leaving is required to contain 0.150 mol. fraction methylcyclopentane, and the extract leaving the column to contain 0.136 mol. fraction methylcyclopentane. A continuous counter-current multiple-contact extraction system with extract reflux is to be used. It is required to determine the number of equilibrium stages with an extract reflux ratio of 10 to 1.

Equilibrium data

The equilibrium data of Darwent and Winkler,[6] expressed on a solvent-free basis for methylcyclopentane and n-hexane, are shown in Fig. 1.

Material balance

The material balance relationships for this problem are summarised in Fig. 2.

To evaluate the reflux ratios in terms of the raffinate and extract phase flow rates entering and leaving the terminal stages, *i.e.* stages 1 and *n*, it is essential to know the saturated flow rates S and S'. In this problem R_o is saturated and consequently $S = 0$. The saturated flow rate S' can be evaluated by equation (1):

$$(E_o + S')y_{os} = E_o y_o + S' x_1 \ldots . (1)$$

where E_o = amount of unsaturated extract phase entering the column, S' = amount of saturated raffinate phase required to saturate the entering extract phase, y_o = composition of entering unsaturated extract phase, y_{os} = composition of saturated extract phase entering stage 1 and x_1 = composition of saturated raffinate phase leaving stage 1.

Taking a component material balance for n-hexane, S' is calculated as follows:

$$(1{,}985 + S')\,0.075 = 1{,}985 \times 0.0 + S' \times 0.778$$

$$S' = 211 \text{ mol.}$$

The amount of extract phase S_F required to saturate the incoming feed can be readily calculated from the saturated feed composition, which has a hydrocarbon content of 0.929. Thus for 100 mol. of feed entering, the saturated flow rate is

$$\frac{100.0}{0.929} = 108 \text{ mol.}$$

The quantity of raffinate entering stage $(f-1)$ is the sum of the saturated feed and the saturated flow rate S', *i.e.* 108 + 211 = 319 mol.

The raffinate leaving the feed stage f is equal to S', *i.e.* 211 mol.

The amount of extract phase leaving stage $(f-1)$ is given by an overall material balance above the feed tray, *i.e.* 2,196 + 319 − 278.5 = 2,236.5 mol.

The above material balance in Fig. 2 can now be re-expressed as shown in Fig. 3 on a solvent-free basis.

Reflux concentration diagram

The overall material balances are expressed graphically by the construction shown in Fig. 4.

Two parallel composition lines, one representing the extract composition y and the other the raffinate composition x, are first drawn any convenient distance apart. The overall material balance is expressed as follows: (1) Join x_o (79.2% iC_6) and y_n (79.8% iC_6) and extrapolate to the difference point (a), such that

$$\frac{y_n a}{y_n x_o} = \frac{R_o}{E_n - R_o} = \frac{375.0}{422.3 - 375.0} = 7.9$$

(2) Join (a) to x_f (40.0% iC_6) and locate y_f such that

$$\frac{y_f a}{y_f x_f} = \frac{R_f}{E_{f-1} - R_f}$$

$$= \frac{195.7}{243.0 - 195.7} = 4.13$$

(3) Extrapolate ax_f to the difference point (b) such that

$$\frac{x_f b}{x_f y_f} = \frac{244.0}{296.7 - 244.0} = 4.63$$

(4) Join (b) x_1 and extrapolate to y_{os} such that

$$\frac{x_1 b}{x_1 y_{os}} = \frac{E_{os}}{R_1 - E_{os}}$$

$$= \frac{206.5}{259.2 - 206.5} = 3.93$$

By joining y_n to y_f and y_f to y_o the varying reflux ratio lines are obtained.

Number of equilibrium stages

The number of equilibrium stages is determined by stepping between the straight equilibrium and operating lines. From Fig. 4 the number of equilibrium stages is 12.6, with the feed entering stage 6.0.

Brown,[1] using the Ponchon and Savarit construction and a mol ratio diagram, calculated between 12.7 to 13.0 stages with the feed entering stage 6.0.

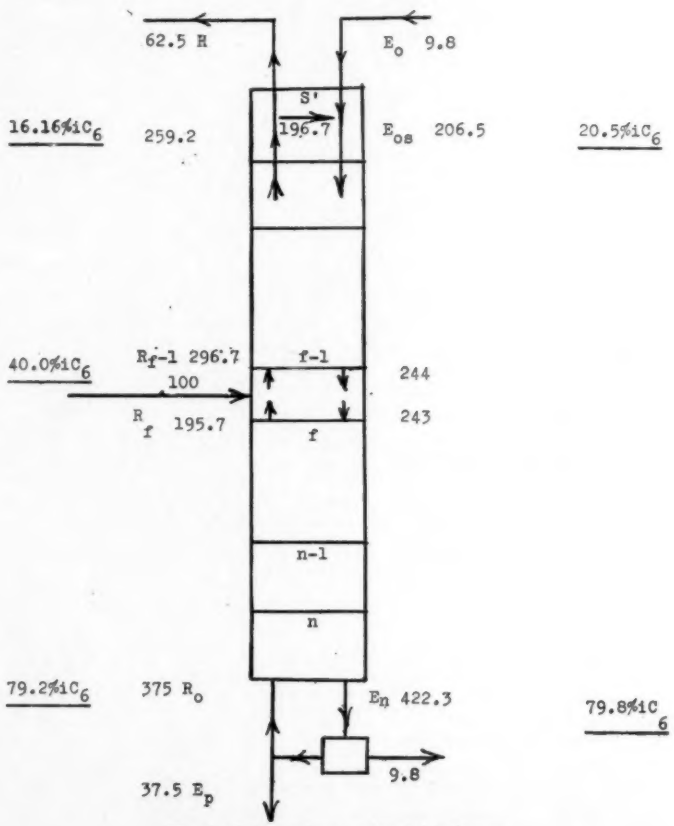


Fig. 3. Solvent-free material balance.

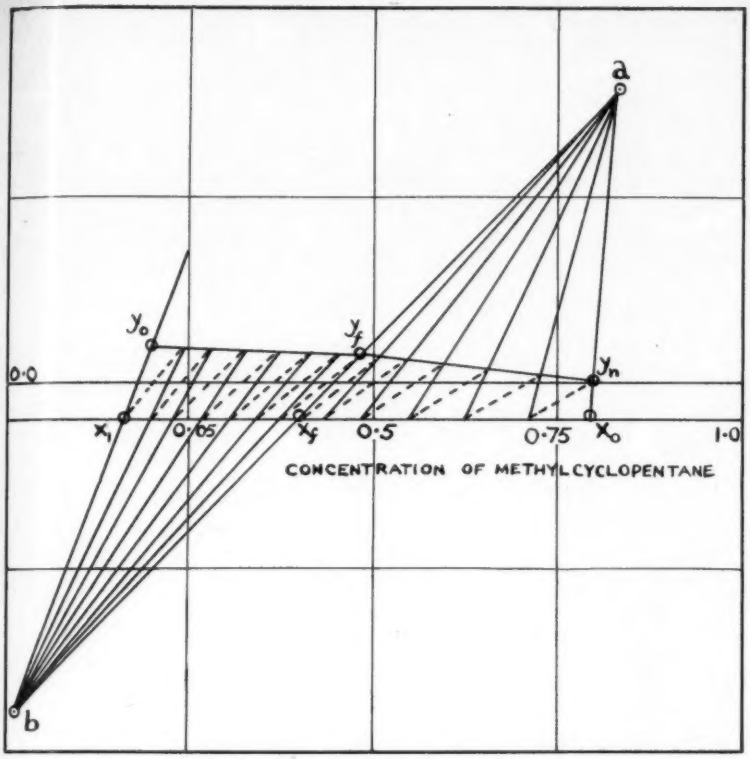


Fig. 4. Number of equilibrium stages.

Thus there is close agreement in the results and the accuracy of the construction in Fig. 4 has been further confirmed by stage-to-stage analysis on a solvent basis. The arithmetical stagewise calculations when re-expressed on a solvent-free basis are in very close agreement with the results from Fig. 4.

When there are more than two components on a solvent-free basis, then Fig. 4 can, as in distillation,[4] be applied to each component. Thus, if there are n components, n—1 constructions of the type shown in Fig. 4 are required.

Comparison of graphical constructions

The Ponchon and Savarit construction as outlined in this paper is similar to that proposed by Maloney and Schubert,[3] as in both cases the difference points are located from the terminal saturated flow rates and compositions. The methods differ, however, in interpreting the variation in flow rates throughout the column. Maloney and Schubert[3] use a mol ratio diagram where the ratio of solvent to total hydrocarbon content in each stream gives the variation in reflux throughout the column. In the proposed method the saturated flow rates above and below the point of entry are also evaluated and thus the variation in reflux ratio plotted directly on the diagram. The summary of the flow rates in Figs. 2 and 3 is most helpful in the practical design of the extraction plant.

NOTATION

E_o = amount of unsaturated extract phase entering the column.
E_{os} = amount of saturated extract phase entering stage.
R_o = amount of raffinate phase entering the column. In this example R_o is saturated.
R_{1s} = amount of saturated raffinate leaving stage 1.
R_1 = amount of saturated raffinate leaving the column.
S' = amount of saturated raffinate phase required to saturate the entering extract phase.
S_f' = amount of saturated extract phase required to saturate the entering feed.
y_o = composition of entering unsaturated extract phase.
y_{os} = composition of saturated extract phase entering stage 1.
x_1 = composition of saturated raffinate phase leaving stage 1.
$1, 2, \ldots n$ = subscript refers to number of stages.
f = subscript refers to feed stage.

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TIN-ZINC COATING RESEARCH

Although the tin-zinc alloy plating process has for some years been successfully operated in many industries, research has been continued at the Tin Research Institute on obtaining the tin-zinc coating by methods which might be more attractive to some users than the established process.

This has resulted in the successful passage through laboratory and pilot-plant stages of a process in which the alloy is plated from an alkaline electrolyte similar to that previously used, but with the cyanide replaced by an organic complexing agent. It is stated in the 1955 annual report of the Institute that, if experience on full scale industrial operation confirms the laboratory finding, the avoidance of difficulties associated with the use of cyanides should make this method a most useful alternative to the existing process.

The Spraying of Liquids in Industry

ADVANCES IN ATOMISATION

The greater use of liquid fuels in industry, increased application of spray evaporative methods of drying and the increase in agricultural spraying have caused greater interest in the processes involved in atomisation. This was pointed out in a paper presented to the Institution of Chemical Engineers, in London, by R. P. Fraser, O.B.E., A.R.C.S., D.I.C., F.INST.F., M.I.CHEM.E. *and P. Eisenklam,* PH.D., M.ENG.SC., D.I.C., A.M.I.CHEM.E. *This paper includes an interesting summary of the types of atomisers available and their uses in industry. Some extracts appear below.*

IT is necessary to atomise and distribute under control many liquids whose properties range from those of chemical solutions, emulsions and dispersions to slurries and even gels. Each application of liquid atomisation is not unique, however, and the chemical engineer can often apply principles which have been used and developed in other industries.

Thus the single-hole fan spray nozzle, first used as a flat-flame gas burner, has recently found its way into agriculture as a liquid sprayer, and is now gradually being introduced for the spraying of liquids in chemical plants. The twin-fluid atomiser, which has been long employed in firing oil, should be particularly suitable for the spraying of heavy suspensions in agricultural appliances, since it would avoid the blocking and erosion which cause trouble in the pressure atomisers now used for this purpose.

There are several basic processes associated with atomisation, such as the hydraulics of flow in the atomiser, the development of the liquid sheet formed, and the disintegration into drops. Amongst the characteristics of a spray which influence the use of an atomiser is the drop size. In spray drying, drop size affects the heat and mass transfer and must therefore be closely controlled. When liquids are atomised for combustion, small drops play an important part in ignition and the rate of combustion. In agriculture, such drops must be avoided because they cause drift. Generally, in the majority of spraying applications, a quantitative knowledge of the surface and volume relations involved is essential.

Types of atomisers

The function of an atomiser is to accelerate and disintegrate a liquid and to disperse the resulting drops. A simple orifice nozzle—or injector—is not an atomiser because, although the liquid is disintegrated if sufficient turbulence occurs in the jet, the drops are not dispersed by the action of the atomiser itself. The most convenient classification of atomisers is according to the source of energy employed.

Because of the inefficiency of energy transfer in the process, attempts to improve the degree of atomisation, the flexibility, or the projection distance (range) have led to the use of various complex types of atomisers. These devices usually combine two sources of energy; for example, a swirl spray nozzle is combined with a medium-pressure, twin-fluid atomiser to improve atomisation and give greater flexibility, or a spinning cup atomiser is combined with low-pressure air to give projection and further disintegration, or pressure atomisers are combined with low-pressure air to give control of direction and of size of the drops.

The most commonly used pressure atomiser for small volumes of liquid is the swirl spray nozzle. This nozzle consists of a swirl chamber into which liquid enters through tangential ports and from which it leaves through a central orifice. The liquid swirls in the chamber around an air core and issues in the form of a hollow conical sheet which disintegrates into small drops. When the formation of the air core is suppressed, a drowned or solid spray is formed. This has a much larger range and produces coarser drops than with an unsuppressed air core.

Another pressure atomiser which has become widely used is the single-hole fan spray nozzle. The principle employed is that of the impinging jet nozzle where jets of liquid are produced from separate orifices. These jets impinge and produce a fan-shaped sheet in a plane perpendicular to that containing them. In the single-hole fan spray nozzle, there is only one formed tip which forces the liquid into two opposing jets inside the tip so that a fan-shaped sheet issues directly from the orifice. The drop sizes from fan spray nozzles are generally larger than those from swirl spray nozzles of equal flow rate and pressure.

Another type of atomiser is the impact atomiser. In one example of this, of extremely simple construction, a plain jet is formed which, on striking a flat plate, issues in a disc-like sheet of liquid which disintegrates into a fine mist at its edge.

Rotary atomisers consist basically of a spinning disc or cup of a wettable surface which is fed centrally with liquid. The sheet thus formed disintegrates on the edge of the rotating member or beyond it. Under controlled conditions of flow, a very uniform main drop size is obtained well separated in space from the small satellite drops which can be centrifuged off. These atomisers provide simple means of producing drops of uniform size.

In twin-fluid atomisers a high-velocity gas stream impinges on the liquid, either within or without the atomiser body. Accordingly, they can be grouped into internal and external mixers.

Uses of atomisers

The need for a better understanding of the processes involved in the disintegration of liquids, emulsions and suspensions has become important in the last 20 years. The greater use of liquid fuels in industry, increased application of spray evaporative methods of drying and the increase in agricultural spraying has caused greater interest in the processes involved in atomisation. The uses may be collated as follows:

Combustion of liquid fuels

In boilers for steam raising.
In furnaces, air heaters, etc.
In internal combustion piston engines.
In jet engines.
In rocket motors.

Process industries

Spray evaporators and driers.
Humidifiers, gas washers and condensers.
Application of surface finishes, paints, lacquers, plastics, slips and metals.

Agriculture

Spray application of liquid chemicals and reagents as insecticides, herbicides, fungicides and defoliants.

Combustion of liquid fuels

Most of the atomisers used for the disintegration of fuel oils are of the swirl spray or twin-fluid type. Although slot-type drooling steam atomisers and spinning cups combined with low-pressure air have been much used, impact nozzles, fan spray, and rotary atomisers have not found much favour.

The inherent flexibility of the twin-fluid atomiser is advantageous in industrial plants where atomatic operation is required or where it is desired to work the equipment on a high- to low-flame principle. The twin-fluid atomiser can deal with liquid viscosities of up to 200 sec. Redwood No. 1 at the jet and, in spite of the increased cost of auxiliaries due to the introduction of a gaseous medium, the atomisers with the greatest power of disintegration are of this type.

For boiler installations (marine or land), swirl spray nozzles are used with capacities ranging from a fraction of a gallon up to 5 tons/hr. The drop size from the large units is, however, so great that a series of nozzles with a smaller capacity of 500 lb./hr. is often preferred. For small steam-raising plant, the twin-fluid atomiser is used because of its greater flexibility.

Process industries

In the process industries, liquids and surrounding media of widely varying properties are employed for spraying. If the liquid is water, or has similar properties, the problems are easily solved by pressure nozzles of the impact or swirl type. The very fine drops required and the limitations on the permitted anxiliary gear often prevent the use of other types of atomisers.

When the liquid will retain a high viscosity, even when preheated to an upper permissible limit, or where mixtures of suspensions or chemical slurries have to be sprayed, pressure atomisers cannot be used satisfactorily. Small channels become blocked and the frictional drag can only be overcome by high pressures which cause pump troubles. Nozzle wear, because of corrosion and erosion, results in larger and larger drop sizes. Although twin-fluid atomisers could handle such liquids and concentrates, they operate at their best when producing small drops, and often these are not required. In such circumstances low air pressures are employed combined with a means of spreading the liquid over a large surface.

In many cases rotary atomisers are more promising. Here the liquid does not have to be forced through small openings and the drop size can easily be varied by change of speed.

In spray drying the properties of the sludges to be dried, the drying conditions and the desired product are often such that only coarse disintegration or shattering is required. Control of product is often regulated by conditions outside the atomiser. Since the capacity of the drier is dependent upon the time required to dry the largest drop during its flight, it is necessary to control the mass and heat transfer by regulating the size and uniformity of the spray. A small reduction in drop size greatly enhances evaporation. Hollow drops have a similar effect. Evaporation during the decelerating flight of a drop is practically independent of the initial drop velocity which can be chosen to satisfy the drop size characteristic of the atomiser and the geometry of the drier only. Both twin-fluid and particularly rotary atomisers are used.

The twin-fluid atomiser of the venturi type is universally used for the spraying of viscous materials such as paints and plastics. Liquid feed is usually by suction around the liquid orifice, and high air pressures are employed to give satisfactory flow projection and distribution. Control of output is achieved by the movement of a pintle in the liquid orifice and a variation in spray form is obtained by changing the area and shape of the air annulus. A great variety of highly compact designs is available, all suffering to a greater or lesser extent from lack of independent control of spray distribution and drop size.

Agricultural and entomological applications

In the past, long- and medium-range large-volume spraying to 'run off' was the only demand in agricultural and entomological appliances, and simple pressure swirl spray nozzles with flow rates of 8 to 800 gal./hr. are still used. They have interchangeable components to obtain a variety of effects.

Whilst swirl spray nozzles have been universally used, single-hole fan spray nozzles are replacing them wherever small volumes of a well-filtered liquid are employed.

Factors affecting drop sizes

There are three factors which affect drop size: the atomiser design, which determines the way in which the liquid is discharged; the liquid properties which influence the behaviour of the disintegrating sheet; and the spraying atmosphere, which affects the mode of disintegration. Methods and equations for determining drop sizes in the distribution pattern have been evolved. The influence of atomiser design, liquid property and ambient pressure on the drop size of a spray have been studied.

Zinc production record

In 1955, world production of slab zinc rose 11% to 2,643,000 long tons. This included an estimated production of 385,000 tons in the U.S.S.R., Poland and other Soviet-controlled territories; production in the rest of the world totalled 2,258,000 tons, compared with 2,047,000 tons in 1954.

The year was one of increased output for all countries except Belgium and Australia. Over one-third of the total was produced in the U.S.A. where, after falling substantially in the previous year, output rose 12% to 920,000 tons. Approximately half of this was produced from imported ores. In Canada, where output had followed the same trend, there was a 36,000-ton increase. Full details for zinc and other metals are shown in the statistical bulletin published monthly by the British Bureau of Non-Ferrous Metal Statistics. A summary of production in the main countries is as follows:

	Thousands of long tons		
	1953	1954	1955
U.S.A.	865	775	920
Canada	221	194	230
Belgium	190	210	207
Germany	148	167	177
Japan	76	100	111
France	77	107	108
Australia	90	105	101
Soviet sphere (est.)	323	377	385
Other countries ...	338	389	404
World total ...	2,328	2,424	2,643

The figures cover the total production of primary and secondary electrolytic and distilled zinc in the form of slabs, ingots and other shapes, and represent the amount of marketable metal available to consumers.

Indications are that world consumption of slab zinc increased by nearly 300,000 tons in 1955 and was roughly equal to production at approximately 2,600,000 tons. In recent years, world consumption has been considerably lower than production.

The 1955 increase was largely due to recovery in the U.S.A., where consumption rose by 180,000 tons to approximately 960,000 tons. Consumption was higher in the United Kingdom, France, Germany and other large consuming countries, though the increases were not so great as in 1954.

British Patent Claims

The following are abstracts of some recent British patents which will be of interest to our readers. These abstracts are reproduced from the weekly Patents Abstracts Journal *by permission of the Technical Information Co. The complete specifications can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, price 3s. each.*

Dry ore concentrating device

Material particles of different specific gravity are conveyed horizontally along a predetermined path, air is breathed upward through the material thus moved to stratify the material by suspending lighter particles, and the movement of heavier particles along the predetermined path is blocked, while the suspended lighter particles continue to move along the path.—742,773, *Dry-Ore-Concentrator Inc.* (*U.S.*).

Magnetic separator

A non-ferrous member lies between a magnetised member and a fluid or powder containing ferrous material to be extracted. The magnetised member is moved relative to the non-ferrous member so as to extract the ferrous material adhering to the latter member.—742,932, *W. C. C. Westwood.*

Concentrating plant

In a plant (*e.g.* for the concentration of spinning-bath liquors), the pipe for the supply to a separation vessel of liquid to be evaporated has a branch through which some of the liquid can be supplied to an inlet in the lower part of a heating member and another branch through which the remainder of the liquid can be supplied to the separation vessel.—742,715, *Akt.-Ges. Kuhnle, Kopp & Kausch* (*Germany*).

Continuous treatment of granular materials with liquids

Process for contacting a granular material with a liquid having a specific gravity lower than the density of the material. The material is passed downwardly over inclined perforated surfaces counter-current to the liquid (or liquid and a gas), the liquid flow being such that the material exerts no appreciable pressure on the inclined surfaces but does not pass into the fluidised state. An apparatus is claimed.—742,784, *Ruhrchemie Akt.-Ges.* (*Germany*).

Crystallising from solution

A hot, saturated solution is cooled by passing it down continuously through a vertical tube-like container having a central metal stem within it supported from the walls by interposed elastic means, a system of cooling coils fixed radially on the stem and a hammer mechanism for producing periodical blows on the stem in the direction of its axis. A mixture of cooled solution and crystals is withdrawn from the bottom of the tube.—742,891, *E. A. Zdansky* (*Switzerland*).

Refining of metals

A blast of refining gas is introduced beneath the surface of a metal bath through a nozzle having a cooling jacket and whose immersed portion extends at a large angle to the vertical. The cooling jacket is divided into two concentric annular chambers by a heat-insulating wall, the cooling agent being introduced preferably to the inner chamber and leaving the jacket through an outlet in the outer chamber.—742,742, *Huttenwerk Oberhausen Akt.-Ges.* (*Germany*).

Pipe joint

A T-section ring is compressed between abutting pipe ends, and inner and outer sleeves surround the ring. Such sleeves are resiliently secured to the respective pipe ends and to each other by elements which yield to a limited extent.—742,904, *Fondazione Emanuele Paterno et al.* (*Italy*).

Centrifugal pump

A pump with an impeller having curved or radial vanes (or a fixed casing having an open-vane impeller) incorporates a complete peripheral shroud with an exit passage which, at the point of exit, is directed towards the axis of rotation or parallel therewith. Communicating passages extend through the impeller vanes in a circumferential direction close to the impeller periphery.—742,705, *R. E. Clough.*

Continuous processing furnaces

A furnace for processing perlite, vermiculite, expandable shale clays, etc., includes, in a heated chamber, a trough of uniform section with a series of scrapers spaced apart along the trough. The scrapers are rigidly mounted on a common support, and each scraper extends over the full width of the trough. Raw material is fed into the trough at one end, and the trough and spacers are moved relatively to one another in such a manner that the material is gradually moved along the trough.—743,038, *G. Carpenter.*

Hydroforming catalyst

Preparation of microspherical particles of catalyst carriers or bases for use in a fluidised hydroforming reaction. Aqueous solutions of aluminium sulphate and sodium aluminate are mixed, the *p*H adjusted to between 9 and 10 and the precipitate filtered, reslurried with water and spray dried. The hydroforming of naphthas, using a hydroforming catalyst mixed with such particles, is claimed.—742,764, *Esso Research & Engineering Co.* (*formerly Standard Oil Development Co.*) (*U.S.*).

Manufacture of chlorine dioxide hydrate

ClO_2 vapour is absorbed from its mixture with an inert diluent in a saturated acqueous solution of ClO_2 at below 15°C., the partial pressure of ClO_2 in the gas mixture being at least equal to the vapour pressure of the ClO_2 in the aqueous phase measured over ClO_2 hydrate.—742,898, *Cardox Corporation* (*U.S.*).

Phosphorus recovery

A charge of calcium phosphate-bearing material, silica and solid carbonaceous material, preheated by combustion heat to 1,200 to 1,300°C., is placed on the surface of a molten slag bath, maintained at high temperature by combined electric arc resistance and slag resistance heating, to reduce the phosphate to elemental phosphorus and melt the calcium silicate formed by reaction of silica with calcium oxide (formed as a result of the reduction). The vaporised phosphorus is recovered.—743,019, *M. J. Udy* (*U.S.*).

Removal of O_2 from gases containing H_2 and H_2S

Catalytic removal at 150 to 350°C. of O_2 from raw gas containing H_2 and H_2S as well as O_2 in a concentration above a certain critical concentration (as defined) for the catalyst. The raw gas, before treatment, is diluted with a gas poor in O_2 so that the mixture produced has a concentration below the critical; *cf.* Brit. Pat. 719,791. —742,912, *Svenska Skifferolje Akt.* (*Sweden*).

Irradiated polythene

Polythene containing 5 to 50% by weight of carbon black is subjected to ionising radiation to produce a substance of increased strength.—742,933, *United Kingdom Atomic Energy Authority.*

WHAT'S NEWS about

★Plant
★Equipment
★Materials
★Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in one of the attached postcards, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

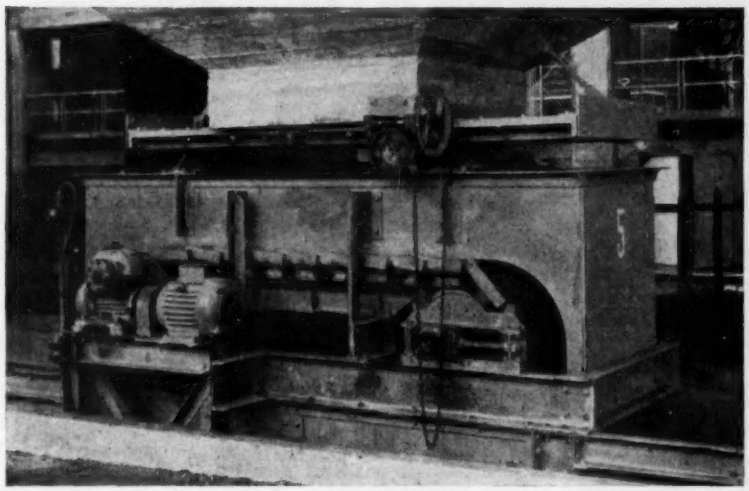
Plate feeder

The function of a plate feeder is to convert an intermittent feed (*e.g.* from wagon tippler, dumper truck or excavator bucket) into a smooth continuous feed suitable for loading a belt conveyor. For light materials such as grain or sand an ordinary rubber and canvas belt can be used, but heavy abrasive materials would quickly wear out such a belt, and a plate belt is therefore used instead. The belt is made up of a number of overlapping ½-in.-thick mild-steel plates mounted on a flat link chain, usually of 7-in. pitch. Brackets are attached to the plates at intervals, depending on the nature of the duties, and each bracket carries a carbon steel roller. The rollers run on a track made from rolled-steel sections, thus carrying the weight of the belt and load. On short-centre feeders it is possible to leave the return strand unsupported, but on longer feeders—say over 6-ft centres—it is better to support both top and bottom strands

The two pairs of terminal sprockets are mounted on carbon-steel shafts running in brass bushes.

The prime mover is usually an electric motor of 5 to 10 h.p. and the power is transmitted to the drive shaft through a worm reduction box and a pair of spur gears. The belt speed most commonly used is in the region of 30 ft./min. If a variable speed is required, an infinitely variable gear box can be positioned between the motor and the driving shaft. The tail sprocket shaft is provided with tension blocks and a screw-type tensioning gear, in order to maintain the correct tension in the plate belt.

A large number of feeders, from 30-in. wide to 48-in. wide and varying in length from 6 to 30 ft., have been designed and manufactured. **CPE 196**

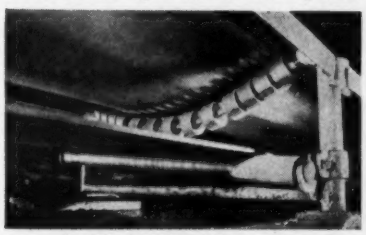


A typical plate feeder.

Flexible conveyor belt idlers

A flexible belt conveyor idler which shapes itself to the load being carried and uses only two bearings is now available in Great Britain for the first time. The idler is designed to prolong the life of belt conveyors in conditions and situations which have so far made their operation difficult.

Known as the *Limberoller*, the idler was first produced in the United States and has been used there in a number of industries including iron and steel mills, chemical works, coke and gas plant and general engineering factories, as well as the mining and quarrying industries. In Britain, the *Limberoller* has been running on test in several plants and the results are claimed to be highly successful.



A 'Limberoller' in action.

The *Limberoller* is an idler with pronounced self-training characteristics. It runs in only two ball bearings which have an efficient lubricant sealing system, while both are positioned above the flow of material. A range of welded steel-pipe idler stands is available, each fitted with standard mounting slots into which the bearings are dropped and locked into place by a spring slip.

Economical operation, low maintenance costs and ease of erection and dismantling are claimed to be features of the *Limberoller*. No belts, cover sheets or decking are required when conveyor sections are being made up and the resulting structure is as strong

C.P.E.'S MONTHLY REPORT AND READER SERVICE

as the conventional type using steel idlers, yet it weighs only one-third as much. The stands are linked by channel steel stiffening rails between each stand, secured by mating lugs at each span. These rails provide spacing and adequate support, but permit slight lateral movement for lining up the belt when erecting the run. Headroom required for a complete conveyor section can be as little as 15 in.

The idler consists of a series of pressure-moulded neoprene discs moulded to a neoprene-sheathed flexible steel cable. This cable is freely suspended from two cadmium-plated precision-type double-row ball-bearings to give a load-conforming catenary. The bearings are fitted with neoprene wiper seals and the edges of these run in annular grooves machined in the inner races. A cartridge-type dustcap seals the blind side of each race.

The bearings are charged and sealed with a long-shelf-life grease which has a temperature tolerance of from −35 to +275°F. This lubrication, it is stated, ensures trouble-free running.

The neoprene discs have flat resilient support surfaces which revolve at the same peripheral speed, giving perfect mating with the belt. They are claimed to be tough and durable, having better abrasion-resisting qualities than steel rolls, and they will not support combustion. They resist most chemicals except extremely strong oxidising agents and aromatic hydrocarbons.

Constant flexing reduces any tendency for material to build up on the belt. The training action helps to keep the belt in line and, because of the positive contact between belt and discs, belt wear is kept to a minimum. **CPE 197**

Larger polythene containers

Polythene containers of very large dimensions have recently been introduced to the market in Britain. Among these is a round tub of 10-gal. capacity, measuring 22 in. in diameter and 11 in. deep, and costing £2 12s. 6d. Another vessel in this series is a bin of 8-gal. capacity, being 15½ in. in diameter and 18 in. deep, and costing £4 15s. 6d.

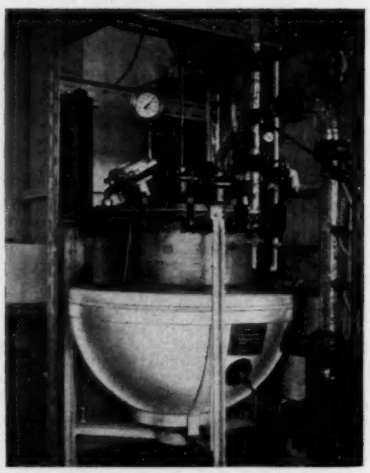
These containers have all the well-known advantages of polythene, being practically indestructible, impervious to the action of corrosive and erosive fluids and light in weight. **CPE 198**

PROPORTIONAL ELECTRONIC CONTROLLER

In some applications where delayed heat transfer is inherent, two-position control cannot give the accuracy of control desired. The proportional electronic controller shown here is designed to meet these conditions in electric furnaces and give control within fine limits and without hunting.

With this instrument, corrections to the controlled heat input are proportional to the deviation from the control set point or desired value, over a band which could be up to 5% of full scale.

CPE 199



HEATERS FOR RESIN KETTLES

For the heating of resin kettles, Isomantles *can be used, and temperatures up to 400°C. can be achieved with standard equipment. Full automatic controls are supplied and a special type is also available for use in flameproof areas, as shown in the illustration. Where fast heating-up rates are essential, the* Isomantle *resistance heaters are now combined with mains frequency induction heating coils.* **CPE 200**

Fume ducts in plastics

For the first time a complete standard range of polythene and PVC tubes and ducts is available for the construction of duct lines for corrosive fumes, marketed under the trade name *Polynert*. The advantage claimed by the use of plastics is that, unlike the metal ducts used hitherto, they are in no way susceptible to corrosion. Metal ducts are soon affected and call for frequent coating in corrosion-proof paints, resulting in heavy annual maintenance costs, it is claimed. Also, the plastic ducting can be quickly and easily erected by a factory's own maintenance staff.

Standard sections are available in 3-ft. lengths, with dimensions graduated in 2-in. 'steps' from 4 to 30 in. The various sections have all the appropriate flanges, elbows, T-pieces, backing rings and joints necessary for fume disposal systems. The thickness of the sheet stock is $\frac{3}{16}$ in. for pipes and fittings, whilst flanges are based on $\frac{1}{4}$-in. stock.

The makers have evolved a set of paper cut-outs representing the various standard sections at a scale of $\frac{1}{12}$. The designer has merely to lay the cut-outs on the plan view and elevations of the building concerned, and the results can be observed without spending a great deal of time drawing-in the system. **CPE 201**

Sawing machine

The *Salan* No. 1 sawing machine is now available for the rapid repetition cutting of light brass, aluminium and plastic sections—true to length, with square or angular ends without fraise.

The sturdy spindle is mounted on dust-proof ball-bearings adjustable to prevent any axial or radial play. The saw arm is carefully mounted and adjustable for wear. Pressure lubrication to all working parts is provided. The action of the vise (which swivels to 45°) is automatic, the final 10° of the hand lever upward stroke slightly opening the powerfully spring-loaded vice clamp. The left hand is free to move the workpiece to the length stop, but only when the saw is in a safe position. On the downward stroke a stop is arranged the moment the workpiece is severed.

The saw arm is balanced to ensure the return of the saw from the workpiece; at all times the saw is guarded but simple to remove. The twin vee belts can be tensioned and are also fully guarded. **CPE 202**

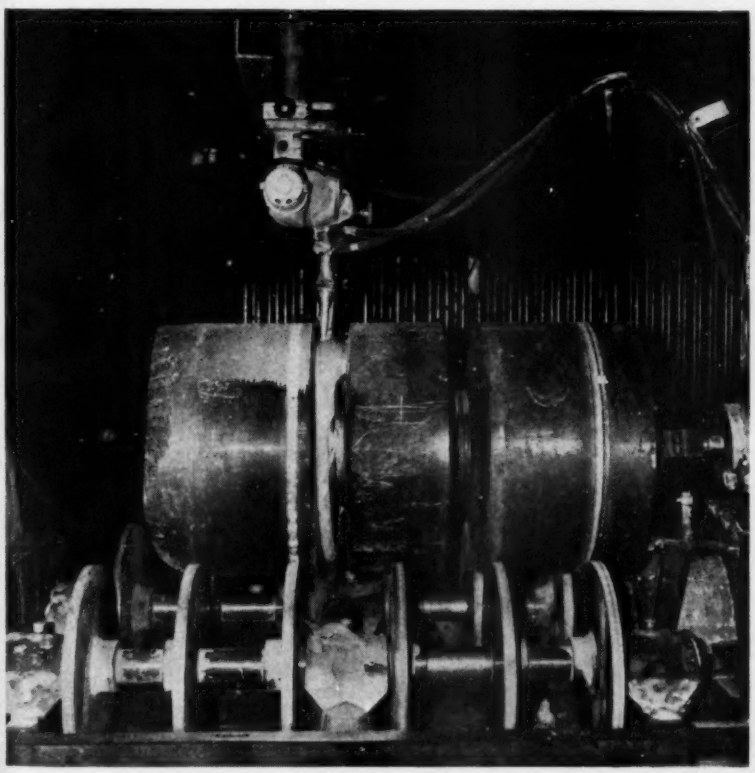
Lead lining for sulphur dioxide recovery units

Sulphuric acid is an invaluable commodity in practically all industries, but often it poses problems. It is, for instance, not only highly corrosive to practically all materials, with the notable exception of lead, but in even small amounts it can become a serious nuisance as an air or stream pollutant. One specialised form of sulphuric acid production, the recovery of waste sulphur dioxide gas from sulphuric acid plants and its conversion to acid, has become an increasingly important field—largely because of the growing emphasis on air pollution prevention. There has been announced recently the perfection of a two-stage exit gas-scrubbing process which has permitted increases as high as 20% in sulphuric acid plant operating rate.

Even at the most efficient rates of operation, contact sulphuric acid plants normally sustain some economic loss in the sulphur which is discharged into the air as exit gases in the form of sulphur dioxide and sulphur trioxide. The two-stage scrubber returns this sulphur to the production unit. Thus not only are economic losses avoided but, in areas where discharge of sulphur dioxide from the stacks could create an air-pollution problem, the process provides effective abatement while at the same time disposing of the recovered sulphur in such a manner as to avoid the equally unwelcome nuisance of water pollution.

In the first system utilising the process in the United States, put into operation more than a year ago, a two-stage scrubber using ammonium-sulphite/bisulphite scrubbing solution returns sulphur dioxide to the production unit and converts part of the acid in the exit gases to ammonium sulphate.

The unit relies for corrosion protection of the steel and concrete construction sections on lead and lead-and-brick linings. The scrubber sump is lined with 12 lb. of chemical lead and covered with acid-resistant brick. The stripper is a steel vessel lined with 10 lb. of chemical lead. In both cases the lead is strapped to the vessel: in the scrubber sump directly to the concrete; in the stripper to the steel. The steel straps used are, in the customary fashion, covered with strips of lead burned to the lining to present a continuous lead surface. The recovery system has been in operation since August 1953. Inspection after one year's service found the lead to be in excellent condition. **CPE 203**



Welding repairs

The production of magnesium carbonate for the making of furnace lining bricks by a British company was seriously threatened recently by the failure in service of a high-temperature rotary kiln. The barrel of the kiln was fractured by fatigue more than halfway round the circumference, and presented a serious problem to the owners.

A repair job was carried out using *Ferron* electrodes, which have been specially designed for welding highly restrained joints, and the kiln was brought back into production with the minimum delay. Welding again proved its value and saved the high cost of a complete replacement.

Welding can also be used to repair giant 20-ton manganese bronze pump impellors which, during operation, suffer cracks up to 1 ft. long. With *Sigma* welding, high-quality repairs can be made on the spot without dismantling the units, and so a complete reclamation of the impellor can be effected at a small cost.

A recent repair operation was carried out on a 22,000-h.p. electric motor-driven pump in which the crack was 11 in. long, 2½ in. wide and 2 in. deep. Four pegs adjacent to the crack were used as strain check points and, by frequent measurements between them, the distortion was kept to a negligible value. The complete weld, made with aluminium bronze wire, had an excellent surface appearance and colour match. **CPE 204**

WELDING HEAVY-WALLED PRESSURE VESSELS

An interesting application of Unionmelt *welding on pressure vessels with a wall thickness of 7½ in. for a test pressure of 27,000 p.s.i. has been announced. All welds had to pass* 100% x-*ray inspection.*

The photograph shows the arrangement for welding with a Unionmelt *D.S.H. welding head positioned over the joint. Four hundred passes were required to deposit 265 lb. of weld metal in each of these two joints and each pass was visually inspected to make sure that the welding was clean and free from any defects. Welding speeds up to 20 in./min. were obtained, making the job an economical proposition.* **CPE 205**

CASTING ALLOY FOR HIGH TEMPERATURES

A new casting alloy, NA22H, has been proved in service for high-temperature applications of up to 2,200°F. A few instances of the performance of this casting alloy include:

(*a*) Endothermic gas generators —60% increase in gas output.
(*b*) Annealing furnace tubes—five times the service and 'still going.'
(*c*) Continuous strip processing line—eight times the service and still operating.
(*d*) Radiant tubes—6¾ years with no alloy failures.
(*e*) Controlled atmosphere muffles —12 times the service and still in use.
(*f*) Furnace fan—six years' continuous service; condition still excellent.
(*g*) Baffle support bars—24 times the service life and still operating.

Among other applications, NA22H has been used successfully for those parts of soaking pit burners subject to most severe temperature conditions. It has also been used for pier caps and rails in high-temperature rotary furnaces, the service life exceeding five years to date. **CPE 206**

Lubricants for open gears

Open gears are used on many types of machines such as punch presses, rubber mills, rotary kilns, tube mills and contractors' plant. With gears of this type, a number of special conditions influence the characteristics required in the lubricant.

Heavy, adhesive, black gear lubricants are available which contain extreme-pressure anti-wear additives. Also they have been rendered fluid by the addition of a volatile non-inflammable diluent that evaporates after the lubricant has been applied. The plastic rubbery film that remains does not tend to hold dust and strongly resists being rubbed off or washed off by water. The lubricants are applied without heating, either by hand or by other devices.

Of these lubricants, *Gargoyle Dorcia* No. 150 is recommended for most installations and is used in general outdoor and indoor service under wet or dry conditions and at all temperatures from 0 to 200°F. At higher temperatures, it has a tendency to sling off when first applied if the gears revolve at any appreciable speed. One of the most remarkable field trial results shown by this lubricant when compared with conventional types is that the material adheres so strongly to gear teeth that periods between application can easily be three to five times longer. The makers point out that, as a result, a very large saving in application labour can be realised and, in those cases where it is necessary to shut down a machine for application, machine idle time is decreased and production increased.

Safety hazards are often encountered in the application of gear lubricants to large heavy-duty machines and the reduction of such hazards due to the long periods between applications is an additional benefit. Also, long intervals between applications make it possible to schedule lubrication for periods when machines are not in regular production. Enforced neglect of required lubrication is thus overcome.

This lubricant is not thrown off when first applied at peripheral speeds as high as 600 ft./min. and at gear-teeth temperatures approaching 200°F. Because of this and the long-lasting nature of the protective films, there is a material reduction in the amount of lubricant used. Both of these factors result in a great reduction in the accumulation of throw-off of lubricant around the machine, in a reduction in staining of product in process of manufacture, and in an all-round improvement in 'housekeeping.'

Another factor is the strong resistance of the lubricant to wash-off by water. It has resisted displacement by rain, snow and process-water far better than any other product.

Another lubricant in this range, No. 500, has all the characteristics of No. 150, but its initial and final body is much heavier. It is used under wet or dry conditions where gear-tooth loads and extreme and where gear temperatures range from 150 to 450°F.

A third lubricant, No. 20, consists of a heavy, black, oil-type product diluted with a solvent. It is fluid at ordinary temperatures and is suitable as a lubricant for moderately loaded open gears.

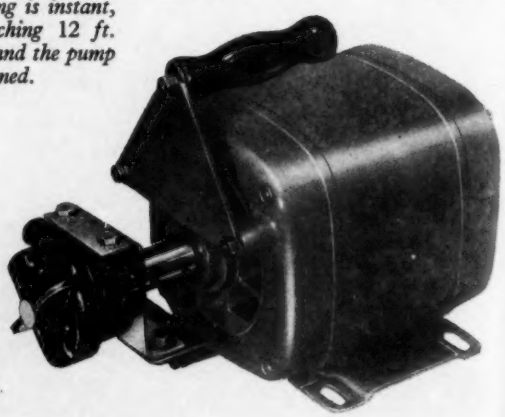
Finally, there is a heavy lubricant of correct body for use in slush-pan lubrication of open gears. In this application the film on the gear teeth is constantly renewed by the dipping gear. The film is not required to set up to the firm coating needed on gears that do not dip into the lubricant. **CPE 207**

PORTABLE SELF-PRIMING PUMP

Portable and self-priming, this plastics pump and motor unit is made throughout of material highly resistant to corrosion; it is easily dismantled for inspection and service.

The body is of tough, moulded plastics, and the impeller of a neoprene rubber compound. Shafts may be of stainless steel or Hastelloy. *For its weight* (19 *lb.*) *and size this plastic unit has a formidable flow*—300 *gal./hr. Starting is instant, with suction lifts approaching* 12 *ft. No foot valve is required, and the pump will lift to* 25 *ft. when primed.*

There is one moving part—the impeller —which is a tough, neoprene unit, lubricated by the fluid being pumped. There are no gears, bearings are of carbon graphite, and the pump will handle thin or viscous liquids at low or high speeds in either direction. It can be mounted at any angle. The cost of a unit for single or three-phase operations is £22 10*s.* **CPE 208**



This corrosion-resistant pumping unit is useful for services such as chemical and many other applications.

Explosion protection and suppression device

A high-speed isolation valve has been developed for use in conjunction with a system of explosion protection and suppression. The typical 8-in. valve illustrated will close in 70 msec. from the application of the operating current and is designed to withstand a pressure of 150 p.s.i.g.

The valve is intended to prevent flame or burning material, as the result of an explosion, travelling from one part of a plant to another, and it has wide application where explosion hazards exist. A typical example is where it is necessary to isolate a bag filter from the effects of an explosion originating in a cyclone. For such a case its operation would be effected by means of an explosion detector located in the cyclone which, in conjunction with an electrical power unit, would provide the operating current a few milliseconds after the commencement of an explosion.

If the interconnecting ducting between the cyclone and bag filter is very short, to extinguish any flame or burning material which might seep through before the valve completely closes a hemispherical suppressor can be incorporated—a combination which gives effective isolation in less than 10 msec.

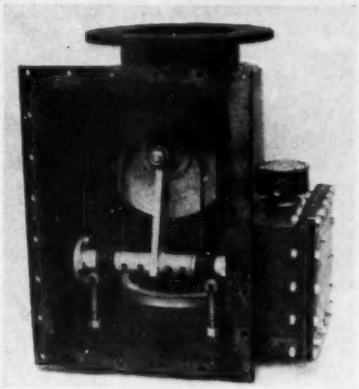
The electrical power unit which supplies the operating current incorporates a number of safeguards, the most important being:

(1) Standby dry batteries are incorporated which come into operation automatically in the event of a mains failure.

(2) A small current of about 2 ma. is bled continuously through the detonator circuit. This current holds in a relay which falls out and gives audible and visible warning if the voltage fails or the wiring is damaged.

(3) A key is provided which upon withdrawal isolates the detonator circuits and renders it impossible to operate them. In the event of maintenance being required within the system being protected the individual concerned would take the key with him.

(4) When a suppression takes place, relay contacts operate which can be used for initiating the automatic shut-down of any item of plant required, *e.g.* valves or electrical supplies to fans or pumps. **CPE 209**



High-speed isolation valve.

Collector for fine dusts

The *Clear-Flo* dust collector unit has been designed for the efficient collection of fine dusts such as limestone, iron oxide, tin oxide, cement, sulphur, carbon black, soda ash and hot metallic oxides. The filter utilises a system of multiple fabric filter sleeves stretched over internal springs and secured to a top spigot plate. A reversed air-flow principle is employed by which air and dust drawn into the collector are subjected to a swirling cyclonic action. The heavier dust is deposited in the dust bin, the finer particles being deposited on the outside of the circular filter cloth. This means that the restrained dust is free to drop off without danger of building up as in the case of filter bags when dust is blown through from the inside. No shaker gear is required. Standard units are available up to 20,000 cu.ft./min. on the same non-clogging principle. **CPE 210**

Dust collector.

Packaged boiler with single pass

The *Swirlyflo* packaged boiler is a complete steam-producing unit wherein the boiler, fuel burner, draught system, feed water and oil service tanks are completely self-contained and on one chassis.

This development was made possible by the use of the *Swirlyflo* firetube, originally developed before the war principally for exhaust gas boilers. These tubes are specially designed to give a very high turbulence to the gas flowing through them with consequent high heat-transfer rates. A very short length of tube is therefore sufficient to extract all the heat from the flue gases, thus obviating any necessity for double-pass boilers, as all the useful heat can be taken out in a single pass of tubes.

The success of the *Swirlyflo* vertical boiler led to the development of the horizontal, packaged boiler, also constructed on the principle comprising one single pass of firetube of very high efficiency—a feature which is possibly unique in this type of boiler.

Both these boilers are of the fully water-cooled furnace type and have the absolute minimum of brickwork insulation. This ensures maximum efficiency of heat transfer in the furnace, leaving the *Swirlyflo* tubes to comb the remainder of the heat from the flue gases.

The oil burner is of the forced-draught, pressure-jet type, giving a highly luminous flame with a high emissivity to the furnace wall. For boilers up to an evaporation of approximately 1,500 lb./hr. the oil burner is of the fully automatic on/off type, whereby the burner is switched on or off to meet steam requirements. For steam evaporation of more than 1,500 lb./hr. the burner is of the modulating flame type which varies the size of the flame to suit the steam demand from the boiler down to approximately 20%

of full output; thereafter it switches on and off as required to maintain the lower output.

A feature of all the packaged-type boilers is that, owing to the fact that the oil burner is of the forced-draught type, the height of the chimney for the boiler is immaterial, combustion not depending on any draught induced by the chimney. Consequently, the height of the chimney need only be sufficient to clear adjacent roof buildings or to meet local byelaw requirements.

The *Swirlyflo* packaged boiler is supplied in sizes up to 10,000 lb. of steam evaporation for vertical boilers and up to 20,000 lb. of steam per hour for horizontal boilers. As the boiler is supplied as a fully packaged unit requiring only chimney extension and steam pipe to be fitted and oil/water and electrical supplies to be connected, it will be appreciated that the installation of the boiler is extremely simple and no expensive foundations or chimneys are required.

Perhaps the most attractive feature of the oil-fired packaged boiler is its clean and simple installation and operation, and the fact that the combustion is so closely controlled that the stack is always smoke-free, thus complying with the most stringent anti-smoke regulations. This latter point is, of course, most important, as more and more attention is being paid by local authorities to the elimination of obnoxious smoke.

Important points to be considered with the smaller fully automatic oil-fired boiler are that it dispenses with the continual service of a boiler-house man and that normal servicing can be carried out by a maintenance engineer.

Packaged boilers are ideal for industrial services, process work, heating and municipal purposes. **CPE 211**

Packless control valve prevents escape of liquids

A pneumatically operated control valve having a positive leakproof metallic bellows seal built in below the conventional stuffing box has recently been introduced to the market. The normal stuffing box is retained and becomes an emergency safety seal. The valve is designed for use on those processes involving liquids which cannot be allowed to escape (even in the minute amounts that might pass the conventional packing gland) because of the danger or loss involved. Such fluids include synthesis gas ($CO + H_2$) which is toxic; chlorine which is corrosive; toluene which is explosive; and the many pharmaceutical chemicals which are very valuable. It is stated that the valve also meets the requirements of processes under vacuum where no leakage is permissible because of vacuum loss or process contamination from the atmosphere.

The bellows seal is housed in an adaptor spool assembled between the body and the bonnet. A close-clearance sleeve surrounds the valve stem, the upper end of the sleeve being locked to the valve stem by a specially designed ferrule and locknut. The lower end of the sleeve is seam welded to a bellows and the upper end of the bellows is seam welded to a flange clamped between the gasketed bonnet and adaptor spool flanges. A positive seal against the line fluid is thus provided while the bellows expands and contracts with the reciprocating action of the valve stem.

According to the manufacturers, a bellows has been developed which has an exceptionally long life and which continues to function perfectly after continuous difficult service, including both throttling and open and shut control valve applications. **CPE 212**

'HYPALON'-LINED HOSE FOR CHEMICALS

A new range of improved chemical hose, the main feature of which is *Hypalon* lining, has been recently introduced by a British firm of rubber manufacturers. It is claimed that laboratory and practical tests have demonstrated the superiority of this new product over the orthodox rubber-lined chemical hose when used for the conveyance of sulphuric acid in concentrations of up to 98%, hypochlorites, chromic acid, hydrogen peroxide and other strong oxidising agents.

Other advantages claimed for the new hose include its toughness and resilience. It is stated that it is not affected by wide variations in operating temperatures.

Hypalon hose has been used without signs of deterioration for well over two years. **CPE 213**

'Arkon' flow indicator.

Flow indicator

A simple but extremely efficient device for providing a visual check on the circulation of liquids is the *Arkon* flow indicator, which is supplied for fitting to pipes of sizes from $\frac{1}{2}$ to 3 in.

It comprises a cast bronze body over which is a small toughened glass dome standing completely clear of the liquid which, as it passes through the pipe, spins a chromium-plated ring situated under the dome. This movement is so definite that it cannot be mistaken or misread and can clearly be seen at a distance from all angles. If the flow ceases, the ring stops spinning, thus giving an immediate warning signal.

The flow indicator can be fitted at any point in the circuit in a horizontal pipeline and is suitable for operation at pressures of up to 40 to 50 p.s.i. The only moving part is the spindle, while the impeller can be supplied for either high or low rates of flow.

It has many applications in industry and is being fitted in the cooling water circuit in condensers, oil coolers, distillation plant radiators, steel works furnaces, etc., also for providing a check on the flow of lubricating oil to gear trains, bearings, heavy machine tools, etc., and that of cooling oil to electric transformers. An interesting use to which it has also been applied is for giving warning of operation of tank overflows. **CPE 214**

Process timer

For use wherever the timing of an industrial or scientific process has to be exact, a seconds timer with an 8-in. dial has been produced. The operation is similar to that of a stop watch. The timer is started by depressing a side lever, and to stop the timing process it is only necessary to return the lever

to its original position. The larger dial indicates seconds from 0 to 60 with a bold subsidiary dial showing 0 to 10 min. Both hands will return to zero when the plunger at the top of the case is pressed down. This action also winds the timer automatically in readiness for the next operation.

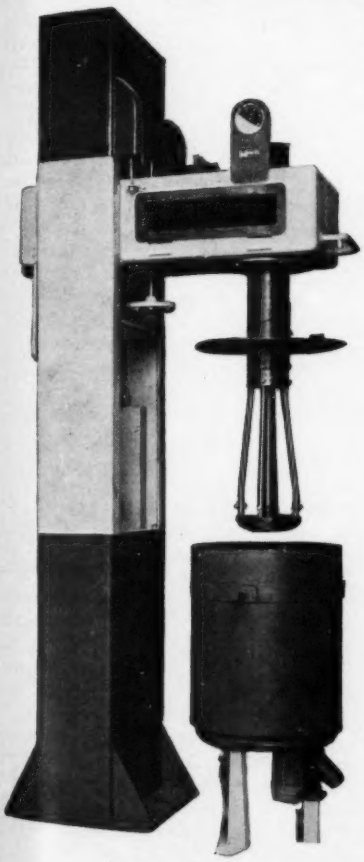
The timer has a robust metal case with three fixing positions. Price: 95s. ex works (luminous dial extra).

CPE 215

Dispersion technique

A *Turbo-Disperser* has been developed which, according to the suppliers, will in one unit replace the standard equipment required for grinding, paste forming and dilution.

The unit has been designed by considering the problem in relation to the theory of the 'flow point.' As the technique excludes impaste, it is claimed that the unit will produce the paint or varnish at the viscosity required in one operation, starting from the most liquid phase (putting pigments in suspension) and leading up by the progressive incorporation of the constituents to the product at its desired viscosity and fineness. The plant, which is stated to be able both to create the circulation of the product at high speeds and at the same time control and vary these speeds as required, consists of a vessel of total capacity of 45 gal., an impeller and an outer stationary crown, a driving mechanism consisting of a 15-h.p. totally enclosed or flameproof motor, with variable-speed drive, and a supporting gantry.



'Turbo-Dispenser.'

The main advantages of the equipment, it is stated, are that:

(*a*) Rate of operation is high: a 6-cwt. batch can be completed in about 1 hr.

(*b*) Cost of the plant is only about one-quarter of that of the necessary plant for standard methods of manufacture.

(*c*) The plant itself takes up little room.

(*d*) Labour is considerably reduced —there is only one plant to supervise and the operator need not be a specialist as in the case of a roll mill.

(*e*) Less handling is involved, in that the vessel only has to be filled and, if desired, the finished product may be run off direct into tins.

(*f*) Cleaning is easy; the impeller itself can be used to clean the vessel by running it in a solvent.

(*g*) The vessel is in stainless steel to facilitate cleaning and is lidded to avoid loss of solvent.

(*h*) Very little maintenance is required.

CPE 216

Pipe with PVC covering.

PVC covering for pipes and ducts

A new patented development for covering pipes and ducts consists of polyvinyl chloride sheet covering, which is supplied in lengths up to 100 ft., and in widths to suit any size of pipe or duct up to 75 in. in circumference. It is provided with a continuous *Flexigrip* fastener, which is air-, moisture- and watertight.

It is claimed that *Pypekover* gives protection against moisture, water and corrosive atmosphere, and also against fungus growth and soil corrosion in underground locations. It provides protection against electrolytic corrosion and, being non-inflammable, will not support combustion. The manufacturers also claim that it does not rot or harden from prolonged exposure to weather conditions, and that water will not penetrate even when pipes are washed down or hosed.

The covering costs less than the usual three coats of paint and is less than half the cost of sewn canvas plus paint; in addition, it can be easily removed and re-used. *Pypekover* is supplied in various colours for identification purposes. The tensile strength of the continuous welded joint between the *Flexigrip* closure and the PVC sheet is said to be greater than the sheet itself.

CPE 217

New ultrasonic thickness gauge

A new ultrasonic thickness gauge, the type 1107B *Visigauge*, operates on the ultrasonic resonance principle by which the thickness of components, of which only one side is accessible, can be measured non-destructively. Direct-reading scales are available for the measurement of thicknesses between 0.005 and 2.5 in. with very high accuracy.

To measure the thickness of a component, the operator places the probe on it, using a little oil or vaseline to obtain a good acoustical coupling. The probe consists of a piezoelectric transducer in a stout casing which transmits a continuous signal of ultrasonic waves into the material being gauged. The signal is generated by an electronic sweep oscillator plugged into the main instrument and connected to the probe by means of a cable.

A series of plug-in oscillators is available to cover the thickness range

of the *Visigauge* in several overlapping steps. Corresponding scales are also available, calibrated not only for steel, but also for other common engineering materials. The instrument can even be used for such heavily damped materials as lead and for other homogeneous materials, for instance graphite, plastics, glass and solid argon.

The outstanding advantage of ultrasonic gauges is the facility and accuracy with which they can measure thickness without the need for drilling holes or dismantling plant. This makes them useful for corrosion surveys on all types of plant and equipment used in the oil, petroleum and chemical industries, since periodic checks can be carried out without interfering with production in any way. **CPE 218**

De-aerating boiler feed water

Dissolved oxygen in boiler feed water is the most important and the most dangerous factor in the corrosion of boiler equipment. Since the importance of de-aeration was first realised, many types of de-aerating apparatus have been designed and built, but, while some of these performed their functions in a satisfactory manner, their complication and consequent expensive character were a drawback. By a simplification in process and design, a British company claim to have succeeded in improving the performance and at the same time reducing the cost of the apparatus and its installation. An important feature of the *Optimum* de-aerator is that it functions as a heater in a feed system and, although exhaust or low-pressure steam is used as an operating medium, all heat utilised is absorbed and retained in the feed water.

A range of de-aerators have been evolved which are suitable for both vacuum and pressure working according to requirements. They allow of violent ebullition taking place at all temperatures of water, provided that the temperature of the entering steam is higher than the leaving temperature of the water.

It is stated that these de-aerators are absolutely stable whether operating under vacuum or above atmospheric pressure. When operating under vacuum conditions, a suitable ejector is provided, but for operation continuously above atmospheric pressure an ejector is not necessary. **CPE 219**

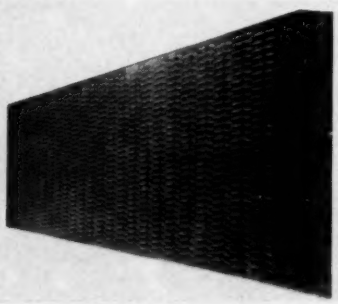
Paints for corrosive atmospheres

A range of chlorinated-rubber paints is being marketed, of which a particular feature is their suitability for coating new asbestos-cement sheets and other substances which are in a highly alkaline state. The makers of these paints point out that, whereas the opinion is commonly held that asbestos-cement sheeting does not need painting, this is not entirely true. Where heavy atmospheric pollution exists, the sheeting can and does become impregnated. This results in unsightly surface patches and, moreover, may constitute a danger to health.

Atlas chlorinated-rubber paints are claimed to be highly resistant to all types of chemical fumes, acids, acid gases and alkaline solutions. In addition, it is stated, they have excellent resistance to petrol and all types of mineral oil, but not to the action of benzene and xylene. It is further claimed that they form a reliable weather coating and are unaffected by moisture.

Normally the paints are applied direct to the surfaces to be protected. No undercoat is required, but two coats of the same material is an advantage. The paints dry in about 1 hr. with a pleasing gloss. Application can be by brush or spray, but the former method is recommended. The covering capacity is approximately 600 sq.ft./gal.

The same makers also supply a range of isomerised-rubber paints which are stated to possess the same ability as the other grade to provide protection for structural steelwork exposed to severe chemical attack. In many instances they are preferred, because they are so much easier to apply, both by brush and by spray, and for the reason that the resultant paint film is of much better build. They also have the useful attribute of withstanding the effects of moderate heat. For asbestos-cement sheeting and for surfaces which come into contact with petrol, etc., the chlorinated type is more satisfactory. **CPE 221**



'PERMALI' SUCTION BOX TOP

An advantage claimed for the use of densified wood laminates for chemical-resisting parts is the ease of accurate machining. This Permali *suction box top is 8-ft. long and contains more than 700 radially slotted grooves for liquid extraction. The moisture-resisting and hard-wearing properties of the material make it particularly suitable for this type of application.* **CPE 220**

Factory floor cleaning unit

A machine has been introduced which can be driven around a factory floor and which performs two functions simultaneously, scrubbing away the dirt and then lifting it from the surface of the floor so that it is left clean and dry.

The machine consists fundamentally of a strong, light-alloy-base casting which contains the traction unit and upon which the other components are mounted. These include two galvanised tanks, one for water and detergent and the other for sludge; a high-speed, motorised air extruder running at about 14,000 r.p.m.; a continuously rated, 1-h.p., brush-drive motor running at approximately 2,000 r.p.m.; lifting jacks and the *Microjusto* wheel control. The unit is battery powered and therefore the danger of trailing cables is avoided.

The traction unit is driven by a constant-speed 24-v. motor supplied from the batteries. Transmission is effected through a heavy-duty single-plate clutch and gearbox having three forward speeds and reverse.

The operator sits astride the machine with all the controls to hand. Clutch and brake levers are mounted on the steering handlebars. Hydraulic valves control the pressure exerted when the brushes are in use, and facilitate brush changing.

The brushes are arranged in such a way that they inter-mesh like gears so that no blind or unscrubbed streak is left behind on the floor, while at the same time clogging is prevented and a considerable degree of self-cleaning is provided for. **CPE 222**

THE WORLD'S FIRST
Fully-Integrated Aluminium Plant

Olin Mathieson's Big Project for Ohio Valley

Plans to enter the aluminium industry with an initial investment of $120 million, and with the world's first fully integrated aluminium plant, have been announced by the huge Olin Mathieson chemical concern in the U.S.

★

The new operation will mark the first time in the history of the aluminium industry when coal mined directly on the site is used to provide the large power requirements for the reduction of alumina to pig aluminium.

★

The location for the plant is the Ohio River Valley, where it seems likely that the Olin Mathieson project will be followed by still further developments in aluminium and other chemical, electro-chemical and electro-metallurgical operations which require large quantities of economical power.

INVESTMENT in the new Ohio Valley operation of the Olin Mathieson Chemical Corporation includes some $90 million for the aluminium plant and $30 million for the power facilities. The alumina plant, the reduction plant and the rolling mill will be on the Ohio River near Clarington, Ohio.

The alumina plant will have a capacity of 23,000 tons p.a., and the aluminium plant 60,000 tons p.a. At first, only about 115,000 tons of alumina will be required for the aluminium plant and the 115,000 tons surplus alumina will be available to the market. Most of the 60,000 tons of finished aluminium will be consumed by the Metals Division of Olin Mathieson. However, in view of the need for flexibility, the Corporation will be both a buyer and a seller of prime aluminium in order to keep the fabricating facilities in balanced supply.

Among other products which the fabricating facilities produce is *Olin Roll Bond*, produced at the East Alton, Illinois, plant and used in many forms of heat-exchange work.

Raw material supplies

Bauxite, the major raw material required for the Ohio River Valley project, will be shipped to the United States from Surinam (Dutch Guiana). Olin Mathieson has signed a long-term supply contract for its initial requirements. The first shipment for stockpiling of the raw material are scheduled for arrival early in 1957.

Depending upon grade, it takes about 2 tons of bauxite to make 1 ton of aluminium oxide (alumina) and 1.9 lb. of aluminium oxide to make 1 lb. of the metallic aluminium. The formula is sometimes quoted as ' four, two, one.' This means 4 lb. of bauxite for 2 lb. of alumina, from which 1 lb. of aluminium is produced by about 9 kwh. of d.c. electricity.

Modern aluminium production

Production of aluminium begins with mining and, since bauxite deposits are normally found near the surface of the earth, open-pit mining is possible. Bauxite beds are exposed by mechanical scrapers, power shovels or hydraulic washing, and the ore is made ready for the crusher by drilling or blasting.

Alumina, a white powdery substance composed of aluminium and oxygen, is then extracted from the bauxite through any one of a number of methods—the most common being the Bayer process. In this process, crushed bauxite is mixed in large pressure tanks with a solution of hot caustic soda made from soda ash and lime. This dissolves the alumina content of the bauxite and removes the insoluble impurities behind by settling and filtering.

The alumina, now in solution, is pumped into precipitation tanks where it is slowly cooled. Aluminium trihydrate settles out in the form of fine crystals which are fed into large rotary kilns at a temperature of about 1,100°C. This process drives off the chemically combined water, leaving aluminium oxide, or alumina.

Three materials make up the final smelting process: (1) alumina; (2) cryolite, an electrolytic substance which dissolves the alumina; and (3) petroleum coke, used in the manufacture of carbon electrodes which conduct electric current through the fused cryolite to separate the aluminium from oxygen.

The smelting process produces aluminium ingots which are used for rolling to produce plate or sheet or extrusion to produce tubing or a variety of other shapes.

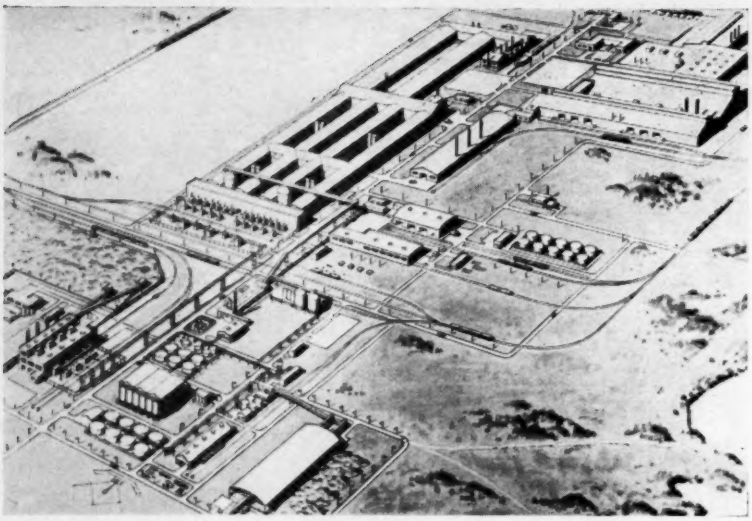
Power plant

The power plant, to be engineered and built by American Gas & Electric, will be slightly upstream from the aluminium plant, on the West Virginia side at Cresap Bottom, and will be connected to the aluminium facilities by a high-tension transmission line. The power plant will be built on a new major coal mine which will be constructed, owned and operated by the Pittsburgh Consolidation Coal Co.

The power plant, which will be known as the Kammer plant, will consist of two units of 225,000 kw. each. One unit will be owned by the Ohio Power Co., a subsidiary of the American Gas & Electric Co.; the other by a joint subsidiary of Olin Mathieson and Pittsburgh Consolidation Coal Co. Both power units will be operated by the Ohio Power Co., and integrated into the American Gas & Electric Co. system. The plant will be designed for development up to 1,350,000-kw. capacity.

The Pennsylvania Railroad is extending its tracks at a cost of several million dollars in order to service the site at Omal, Ohio, near Clarington, Ohio.

This location will take advantage of the vast coal resources of West Virginia. United States' coal resources are estimated to be over 2,000 billion



An artist's conception of Olin Mathieson Chemical Corporation's primary aluminium facility. On the extreme left is the power plant with the alumina plant immediately to its right. The reduction plant is the long building shown in the upper centre of the illustration, with the rolling mill in the upper right. Not shown in the picture are the coal mine and carbonisation plant to the left.

tons and a substantial share of these resources are located in the states adjoining the Upper Ohio River. This aluminium installation is a major new use of electric power produced from coal and should lead to additional like developments. The coal reserves within the area of the new Olin Mathieson operations have been estimated at more than 300 million tons. The initial requirements of coal are about 2 million tons p.a., and reserves are adequate for expanded operations in the future.

Site advantages

The selection of the two sites came after a search of many months, and after dozens of locations had been carefully studied. The following factors resulted in the choice of the Ohio and West Virginia sites:

(1) A desirable site adjacent to large, high-quality coal deposits which make possible an almost unlimited supply of economical electric power.
(2) Proximity to the centre of the aluminium buying market.
(3) Location on deep water transportation.
(4) Accessibility by rail from east coast ports.
(5) Easy shipment of alumina and aluminium out of the area as well as receipt of bauxite to the plant site either by rail or water.
(6) Sufficient acreage on the two sites for substantial expansion in the future.
(7) Availability of electric power by a major utility system of proven efficiency.

Financing of project

The new aluminium plant will be financed from the company's own resources and a newly negotiated long-term loan to the amount of $60 million. The power plant will be financed entirely through a long-term loan of $30 million from the insurance company to the power subsidiary corporation, of which Olin Mathieson will have a 50% interest.

RECENT PUBLICATIONS

Filtration. A comprehensive manual of filtration especially written for product designers is available from Purolator Products Inc., U.S. It describes numerous filter applications and deals with such design considerations as flow rates, viscosities of fluids, and contamination to be removed, as well as filter costs, space requirements of the designer, types of filter elements and the proper selection of elements.

Selenium rectifier equipment. An illustrated brochure on this subject includes a description of cathodic protection equipment for preventing the corrosion of underground pipe work and other metal structures. Among other applications of dry plate rectifiers covered in this publication, available from the General Electric Co. Ltd., are some in precipitation equipment, electronic computors, control gear, etc.

Mechanical handling plant is the subject of a profusely illustrated 20-page brochure from Robert Dempster & Sons Ltd. It includes details of coal, ash, coke and oxide handling plant; telphers; wagon tipplers and skip hoists.

Coal preparation has become of increasing importance in Britain since the war and a number of new plants using dense-medium processes are under construction or projected. One of these dense-medium processes is the Ridley-Scholes process and this is discussed in a 24-page illustrated booklet issued by Mitchell Engineering Ltd. As well as some general comments on coal preparation and cleaning plant, the booklet contains descriptions of actual installations at collieries, including the big new coal-cleaning plant at Lynemouth.

Fine grinders. Publication No. 8301 from Sturtevant Engineering Co. Ltd. describes machines for the superfine reduction of many materials where the production of fine dry powders smaller than 300 mesh is required, from about 1 to 20 microns. Briefly, the Sturtevant *Unicum* and *Victoria* mills are screenless, extra-high-speed hammer mills into which the material is fed at a regulated rate and from which the fine product is drawn off by a regulated air current. Product size is controlled by means of an air selector and the oversize is returned by gravity to the mill, while the fine product is collected into a cyclone to which there is usually added a filter.

Gland packings. In terms of size and cost a gland packing is, in relation to the equipment in which it is used, a small, almost insignificant component, but nevertheless it has a major role to play in the efficient operation of the mechanism. This is pointed out in the introduction to a well-produced 64-page illustrated catalogue issued by Crane Packing Ltd., the greater part of which is devoted to the numerous styles of gland packings included in the company's *Cranpac, Superseal* and CF2 series. CF2 is a new plastic material used for gaskets, valve packings, etc., as well, and these are also featured in the catalogue.

World News

GREAT BRITAIN

Queensland uranium for U.K.

The United Kingdom Atomic Energy Authority have, with the consent of the Government of the Commonwealth of Australia, entered into a contract with Mary Kathleen Uranium Ltd. to buy, for a number of years, uranium concentrates to be produced in the Mary Kathleen mine in north-west Queensland.

Mary Kathleen Uranium is a member of the Rio Tinto group of companies. An Australian subsidiary of Rio Tinto will be responsible for the management of the mine. The U.K.A.E.A. have undertaken to lend up to £5 million to bring the mine into production. The remainder of the capital is to be found by Rio Tinto, who are providing up to £2¼ million for this purpose.

The Mary Kathleen mine is situated some 500 miles from the coast at Townsville and about 40 miles from Mount Isa. The ore is pitchblende associated with allanite, being a complex rare-earth deposit of a type which has not hitherto been mined for uranium, but no undue difficulties are expected in treatment.

Record plastics output and exports

The British plastics industry had a record production and export year in 1955, it is announced by the British Plastics Federation. Output reached about 320,000 tons, an increase of 46,000 tons over the 1954 total and more than double the production of five years ago (155,000 tons in 1950). Practically all branches of the plastics industry improved their production and the increase was particularly marked in thermoplastics materials. Various expansion plans will mean still higher production capacity in 1956.

Exports of plastics materials alone in 1955 amounted to nearly 85,000 tons, valued at nearly £23 million, a rise of more than 11,000 tons and, by value of £2¼ million on 1954—the previous highest figures.

The tonnage exported is more than four times that for 1947 (21,000 tons) and approaching 20 times that for 1938 (4,300 tons).

Glass firm forms German company

Sales to Germany of glass pipeline and industrial plant by Q.V.F. Ltd. (a member of the Triplex group of companies) have increased so rapidly in the past few years that a subsidiary company has now been formed in Germany, with headquarters and works at Wiesbaden. The subsidiary, Q.V.F. Glastechnik GmbH., will manufacture pipeline and plant to implement the range imported from England.

Before the war, Germany had a virtual monopoly of industrial glassware manufacture.

New oil-gas project

Instructions have been received by the Power-Gas Corporation from the South Eastern Gas Board to proceed with the construction of a *Segas* catalytic oil-gas plant to be constructed at the British Petroleum Co.'s Isle of Grain site in Kent. The plant will have a capacity of up to 20 million cu.ft./day of town gas and will supplement the existing supplies distributed through the grid system of the South Eastern Gas Board from Sittingbourne, Kent, to Guildford, Surrey. It is claimed that it will be the largest cyclic catalytic gas-making installation relying solely on oil as its raw material.

This type of plant has previously manufactured gas from heavy oil at York and from heavy oil and light distillates at Sydenham. Other *Segas* plants are now being built in Britain and in Europe. The Isle of Grain plant will make use of refinery residual products such as heavy and light fuel oils, gas oil, light distillate and liquefied petroleum gases for manufacturing town gas and it is expected to be in production by the autumn of 1958.

Oil refining progress

The U.S. oil industry will invest capital in 1956 on crude oil production and refining at the record figure of about $5,300 million, divided as to $3,763 million for production and $825 million for refining and petrochemical plants, increases of 6 and 13% respectively over the previous year. The rest of the free world's production now runs ahead of that of the U.S. North Borneo is becoming a great producer of crude oil.

These facts are included in a report issued by the Council of British Manufacturers of Petroleum Equipment, which contains the chairman's summary of the Council's work in July-December 1955.

It is pointed out that Commonwealth countries have greatly improved their economic position by encouraging home refining of crude oil. Very large expenditures have been made in the U.K., Australia, Canada and India, and these countries are now self-sufficient in their petroleum products requirements and, in addition, can export products abroad.

I.C.I. events

Polythene project in India. The approval of the Government of India for a project to manufacture polythene in India has been obtained by Imperial Chemical Industries Ltd. The manufacture will be undertaken by the I.C.I. associate, the Alkali & Chemical Corporation of India Ltd., in which the Indian public has a substantial shareholding. Technical assistance in the design, construction and operation of this plant will be provided under agreement by Imperial Chemical Industries Ltd. The project will involve a total investment of about Rs. 3 crores (£2¼ million).

It was in the research laboratories of I.C.I. Ltd. in the U.K. that polythene was first discovered. The process to be used in India will be that developed by I.C.I. and used in the manufacture of *Alkathene*. The use of this product in India has been developed by I.C.I. (India) Ltd., who have operated a plant at Calcutta for the manufacture of film from imported granules since 1953.

Fibres Division. I.C.I. is forming a Fibres Division responsible to the fibres director, Mr. P. C. Allen. The new Division takes over responsibility for the manufacture and business of *Terylene* polyester fibre from the *Terylene* Council, which is being dissolved, and of *Ardil* protein fibre from the Nobel Division. The Fibres Division will be responsible for all the company's research and development work on man-made fibres, excluding nylon. The Division's board will be the same as the *Terylene* Council as at present constituted, and its headquarters will be at Harrogate.

Cheaper 'Fluon.' Successful operation of its new large-scale plant has enabled I.C.I. to reduce the price of *Fluon* polymer (PTFE) from a development price of £5 to £2/lb.

Change of name

An announcement from the Creamery Package Mfg. Co. Ltd. states that, following the outstanding success in so many varying fields of the continuous processing principle developed in recent years, the company is making its title more appropriate to its current activities and the name of the company is being changed to C.P. Equipment Ltd.

Also, production is being transferred

from Bristol to the Mitcham premises which will enable both home and overseas visitors to inspect more conveniently in the London area the wide range of C.P. products now being manufactured.

New orders for heat exchangers, coolers and furnaces

Among recent orders received by Brown Fintube (G.B.) Ltd., a subsidiary of Birwelco Ltd., of Aston, Birmingham, has been one from the Kellogg International Corporation for a quantity of multiple-section heat exchangers to be used in the processing of hydrocarbon gases of relatively low molecular weight at the Wilton works of Imperial Chemical Industries Ltd. Some of the exchangers were designed and constructed to withstand operating temperatures as low as –310°F. This is one of the first subzero temperature applications of Brown *Fintube* exchangers in Britain, and choice of materials and construction techniques were to very rigid specifications.

Other orders include one for a number of heat exchangers, to be supplied in collaboration with Etudes et Recherches Industrielles, of Brussels, and the Lummus Co. Ltd., for a new plant at Antwerp operated by the Société Chimique des Dérives du Pétrole (Petrochim). The plant is for the manufacture of petrochemicals and is scheduled to go on stream in 1956.

New company

The formation of an associate company, Plessey Nucleonics Ltd., to handle their increasing activities in the atomic field is announced by the Plessey Co. Ltd.

Electric equipment for Canada

Contracts for electric conversion equipment valued at over £2¼ million are being placed in the U.K. by the British Aluminium Co.'s subsidiary, the Canadian British Aluminium Co. Ltd. The contract being placed with the British Thomson-Houston Co. covers the supply of mercury-arc, pumpless, steel-tank rectifiers with associated transformers and switchgear to the value of over £1¾ million, while the English Electric Co.'s contract will cover transformers and switchgear to the value of about £½ million.

The equipment to be provided is for supplying electricity at 100,000 amp. d.c. at 850 v. to furnaces for the electric smelting of aluminium. The new smelting plant is to be built and operated by the Canadian British Aluminium Co. and will be situated at Baiecomeau, Province of Quebec. This is a township which has grown up since 1936 as the result of the building there of a paper mill by the Quebec North Shore Paper Co., who are partners with British Aluminium in the new aluminium development.

The contracts were obtained against keen overseas competition and, at a total installed capacity of 190,000 kw., it is the largest order yet placed in the United Kingdom for rectifier conversion plant.

Electric heating developments

An interesting development in mains frequency electric heating equipment has been an application to chemical process plants; an equipment is being manufactured for heating a varnish vessel requiring a closely controlled heating cycle, and it is expected that more accurate results will be obtained than with immersion heaters or a steam or vapour jacket.

This is one of a great many developments discussed in a review of 1955 activities issued by the Metropolitan-Vickers Electrical Co. Ltd. Also in the field of induction heating, three installations for the melting or heating of special materials have been commissioned during the year at various establishments of the U.K. Atomic Energy Authority. One of these is designed so that two vacuum furnaces can be operated simultaneously from one high-frequency generator.

The company also reports that, to meet modern operating conditions, a new range of h.f. motor generator sets has been developed with power outputs from 100 to 300 kw. at 2 kc/s and from 100 to 200 kw. at 10 kc/s. In these sets, seven of which are already in course of manufacture, the rotors of both generator and motor are mounted on a common shaft with ball-location and roller bearings of the constant-level oil-lubricated type. Totally enclosed, water-cooled, air-cooled sets are available for operation in dirty or dusty atmospheres.

SOUTH AFRICA

Anglo-American Corporation and titanium

The Anglo-American Corporation purchased a three months' option for £10,000 on the assets of the Titanium Corporation of South Africa last month. It is understood that, if the option is exercised, Titanium Corporation will receive £250,000 and a 10% interest should a new company be formed.

In 1955, Titanium Corporation exported 2,000 tons of ilmenite.

RHODESIA

Manganese mining

The Vanadium Corporation (Rhodesia) Ltd., has bought the Bahati manganese mine near Fort Rosebery and hopes to increase production to 2,000 tons a month.

A BRITISH PUBLISHER LOOKS AT AMERICA

Since the war Mr. W. Leonard Hill, chairman of the Leonard Hill publishing group, has made several trips to the United States and has travelled many thousands of miles in that country, visiting industrial research establishments from New York to Texas. He made his last trip just before Christmas and the opportunity was taken by the company to arrange a reception at the Royal Society of Arts in London during which Mr. Hill summarised his most recent personal impressions of America and the Americans in a lively and entertaining talk.

Mr. Hill was introduced to his audience of industrialists, scientists and businessmen by Mr. J. E. Currie, vice-president of the American Chamber of Commerce in London. Among those who accepted invitations were: Admiral Charles Lyman (U.S. Naval Attaché in London); Mr. J. B. Cross (Cross-Courtenay Ltd.); Mr. V. W. Dale (British Electrical Development Association); Mr. L. S. Davis (W. J. Fraser & Co. Ltd.); Mr. J. L. Good (British Chemical Plant Manufacturers Association); Mr. W. Q. Hull (American Chemical Society); Mr. E. R. Keeble (S. H. Benson Ltd.); Dr. A. H. Leckie (Iron and Steel Board); Mr. W. C. Paterson (Head Wrightson Processes Ltd.); Mr. C. A. Rommer (Consolidated Engineering Co. Ltd.); Mr. K. Saunders (Carl Canzler (London) Ltd.); Dr. L. L. Shreir (Battersea Polytechnic); Mr. L. E. Skagerlind (A. Johnson & Co. (London) Ltd.); Mr. E. C. Weston (Eimco (Great Britain) Ltd.) and many others.

Mr. Hill's talk was illustrated with a number of enlarged photographs, several in full colour. He summarised his impressions thus: 'Americans have more spiritual life (than the British), whereas in business they are more effective and materialistic. They have few false loyalties. They rejoice and gain strength in their freedom from hereditary privilege, and they are fair dealers. Their standard of education for life is superior to ours, and their higher education is higher. They do not dissemble. They are somewhat artless'.

★ Personal Paragraphs ★

★ **Sir Henry Tizard,** G.C.B., A.F.C., director of Glaxo Laboratories Ltd. and Solway Chemicals Ltd., and **Mr. Frank Schon,** chairman of Marchon Products Ltd., have been appointed to the board of Albright & Wilson Ltd.

★ **Mr. J. L. Armstrong,** finance director, has retired from the board of Imperial Chemical Industries Ltd. **Mr. P. T. Menzies** has been appointed an additional director and has taken over the duties of finance director.

★ **Mr. J. K. Batty,** joint managing director of the Alkali Division of I.C.I., has been appointed Alkali Division chairman in succession to **Mr. W. M. Inman,** who retired from the company's service on February 29.

★ Additions to the board of directors are announced by Hercules Powder Ltd. **Mr. C. H. B. Rutteman** has been appointed chairman of the board of the British company, and **Mr. H. E. Hartzell** will take office as managing director. New directors appointed to the board are Mr. T. E. Breakell (secretary), **Mr. E. F. Parker** and **Mr. C. R. Colman.**

★ **Mr. T. A. C. Moorhouse** has been appointed northern area technical representative of Measuring Instruments (Pullin) Ltd.

★ **Sir Ben Lockspeiser,** K.C.B., F.R.S., has, on reaching the age of 65, retired from the post of secretary to the Committee of the Privy Council for Scientific and Industrial Research. **Prof. H. W. Melville,** F.R.S., who is now Mason Professor of Chemistry at the University of Birmingham, has been appointed in his place and will take up his new appointment in August. Prof. Melville is 47 and his personal scientific interests lie in the field of physical chemistry. At the outbreak of World War 2 he became scientific adviser to the Chief Superintendent of Chemical Defence and later was superintendent of the Radar Research Station. Apart from his academic distinctions and awards, he has gained a high reputation as a scientific counsellor.

Mr. F. Schon.

★ Formerly one of the most prominent members of the seed-crushing industry in the north of England, **Mr. Cecil Hodge Robson** has died at Ashprington, Totnes, Devon. When he retired five years ago because of ill-health, he was a director and northern area manager of British Oil & Cake Mills Ltd., of which his father, the late Mr. Edwin Robson, was formerly joint managing director.

★ **Mr. F. N. Judson,** Mobil Oil Co.'s general sales manager (industrial), has retired. He is succeeded by **Mr. G. M. McGavin.** Two years ago Mr. Judson celebrated 40 years of distinguished and varied service in the company and, in recognition of his contribution to the affairs of the oil industry throughout these years, he was awarded an M.B.E. in the 1956 New Year's Honours List.

★ **Dr. W. E. de B. Diamond** has relinquished his position as director of the British Plastics Federation and his duties for the time being have been taken over by **Mr. C. J. G. Stanley,** who has for some time been the manager of the Federation, assisted by **Mr. Basil C. Aldis,** who was assistant to the director.

SWITZERLAND

Cellulose plant projected

A plant to manufacture 30,000 tons of kraft cellulose a year is to be built in Switzerland, according to local Press reports. A new company which has been set up to execute this project is said to be connected with the Thiel paper group. Its capital is said to amount to 100,000 Swiss francs.

At present, all the kraft sulphate pulp used in Switzerland is imported, but the new plant's scheduled output would cover the country's entire needs in this field. It will make use of various species of local timber that have not yet been used by the Swiss paper industry.

BRAZIL

Union Carbide plans polythene plant

The Union Carbide & Carbon Corporation has announced plans to build a polythene plant in Brazil with sufficient capacity to ' satisfy completely the most optimistic ' of Brazil's needs for the next ten years. It will be located at Cubatao, near Santos, Sao Paulo State, and ownership in it will be vested in a wholly owned subsidiary.

The plant will be adjacent to the ethylene plant of Petrobas, the Brazilian Government's petroleum authority. The contract between Petrobas and Union Carbide calls for adequate supplies of ethylene on a long-term basis.

SWEDEN

New paper pulp factory

The Katrinefors Aktiebolaget is to start a new factory in Mariestad for the manufacture of semi-chemical paper pulp from leaf-wood. Capacity will be between 10,000 and 12,000 tons p.a.

The company, a subsidiary of the Swedish Match Co., at present turns out about 25,000 tons p.a. of sulphite pulp, which is then manufactured into paper and cardboards of varying types.

CEYLON

Factories taken over

A caustic soda factory which was put up by the Government at a cost of 11 million rupees is among three factories which are being taken over by Government-sponsored corporations. Administration of the factories is being entrusted to these corporations in order to increase their efficiency.

FRANCE

Carbon black project

A carbon black factory is being built on the banks of the Etang de Beurre. 90% of the French consumption of carbon black is at present imported from the dollar area.

BULGARIA

Copper plant

Construction of a large new copper refinery began recently. Scheduled to be completed in three years' time, it will not only produce pure copper, but also blue vitriol and sulphuric acid.

CANADA

Xanthate project

A plant to produce xanthate for Canada's growing mining industry is to be built by North American Cyanamid Ltd. The new facilities, which are expected to be completed by the end of 1956, will be located at the company's Welland plant in Port Robinson, Ontario.

Xanthate is a reagent widely used in the flotation process of ore concentration. Company officials pointed out that production from the plant will be the first in Canada.

It is also announced by American Cyanamid that manufacturing capacity for two major products is being increased at the Welland plant, which employs about 1,000 persons. Facilities for the production of *Amanol* nitrogen solutions, used as agricultural fertilisers, will be doubled this year and, in addition, the equipment for manufacturing anhydrous ammonia will be modified to achieve greater capacity. The plant began producing nitrogen solutions in the spring of 1955 and was the first plant in Canada to move into this relatively new field. Previously this type of fertiliser was imported from the United States.

Natural-gas plant

Pacific Petroleum Ltd. and its associates are to build an $18-million natural-gas-treating plant to process Peace River gas before delivering it to West Coast Transmission Ltd. for piping through British Columbia and United States Pacific north-west.

The plant will have a capacity to process 300 million cu.ft./day of gas. It will also turn out some 275 tons of sulphur, 1,700 barrels of gasoline, 500 of diesel oil, 300 of propane and 600 of butane daily. The new plant is expected to be completed by the autumn of next year.

New synthetic rubber works

An Ontario synthetic rubber concern, Polymer Corporation, is planning a $5,650,000 programme of new capital works this year. New capital expenditure includes $3 million for a new butadiene plant and $1,950,000 for improvements and alterations to the present plant.

DOMINICAN REPUBLIC

Gypsum deposits

New gypsum deposits have been discovered at La Lista in Barahona Province, under the auspices of the Agricultural and Industrial Credit Bank, and provide additional deposits to those worked in the same area at Las Salinas. It is expected that considerable amounts of gypsum will become available for export to the U.S.

WESTERN GERMANY

Chemical engineering lectures

The annual congress of the Dechema for 1956 will be held in Frankfurt am Main during the period June 6 to 9. The main theme of the series of plenary lectures to be delivered at this Congress will be 'The Basic Principles of Chemical Engineering as Applied to Chemical Reactions on a Large Scale.' This theme will be treated in a series of about six plenary lectures to be delivered by scientists, both German and foreign, of international repute. It is also proposed that a series of brief discussion lectures will be delivered on the latest developments in research and practice which are not treated in the series of plenary lectures.

More chemicals from coal

Output rose in almost all sections of the West German coal chemicals industry in 1955. Some 1,800,000 tons of crude tar were produced, against 1,610,000 in 1954, and the output of crude benzole rose to 610,000 tons from the 440,000 tons produced in the previous year. The 490,000 tons of sulphate of ammonia manufactured in 1955 showed a less marked increase from the 1954 total of 440,000 tons.

In spite of the higher level of production, tar products sold well and imports of pitch rose as exports fell. Naphthalene exports were also down. Imports of benzole, however, were affected by the increased production and fell to 84,000 tons from the 1954 total of 133,000 tons; prices declined in view of offers of cheap U.S. benzole generated from crude oil.

New ammonia works

A new factory for the manufacture of ammonia by the Haber process is to be built in Western Germany at Wanne-Eickel by Steinkohlenbergwerk Hannover-Hannibal A.G., a firm founded in 1953 as a subsidiary company of the Friedrich Krupp combine. The plant, which will cost about £2 million, has been designed for a production of 42,000 tons p.a. of liquid ammonia and is expected to be in operation in April 1957.

An old Fischer-Tropsch plant for the hydrogenation of water gas, belonging to another company of the Krupp combine, Krupp-Kohlechemie GmbH., will be taken over. Where natural gas is not available, the Fischer-Tropsch synthesis is no longer a paying proposition, but the existing water-gas plant can be used for the Haber process more or less as it is and other parts of the Fischer-Tropsch plant will come in very useful.

According to *Chemische Industry*, it is planned to convert about 60% of the produced ammonia into ammonium sulphate. The rest will be sent to another company for conversion into nitric acid by catalytic oxidation.

EASTERN GERMANY

Five-year-plan results

The East German chemical industry, though efficient, had failed to meet growing demands for fertilisers, it was stated in a report by the State Planning Commission on the results of the first economic five-year plan, which ended last December.

It was also stated that last year the foundation stone had been laid for 'the biggest brown coal treatment plant in Europe,' near the coal basin of Senftenberg, and that it would be in full production by 1964.

SPAIN

Industrial events

A factory to produce 20,000 tons of sulphur annually has been opened at Hinogedo, near Torrelavega. This output should render further imports of sulphur unnecessary. At Jerez a factory for the production under a German patent of cellulose from wheat straw is to be built by "Celulosa Andaluza".

The state owned Empresa Nacional de Aluminio, of Valladolid, has been authorised to increase its output capacity to 10,000 tons per annum. This extension provides for 15 additional furnaces of 50 KVA, and the substitution of the 48 existing furnaces (of 25 KVA) by 50 of 50 KVA each.

MALAYA

Fire-resistant paste

A Singapore firm, the Universal Fire Resisting Paste Factory, is planning to mass-produce paste which they claim will render wood resistant to fire and decay. At present the factory is operating on a restricted scale; about 80% of the present production is being exported.

CUBA

Paper from bagasse

Official assistance has been requested for the installation of a new factory near Guines for the manufacture of paper from bagasse. The factory will be situated within easy reach of four of the most important sugar mills in Cuba.

NORWAY

Norsk Hydro's expansion

Norsk Hydro, Norway's biggest industrial concern, is to increase its share capital by 50% to, altogether, £11,900,000. The Norwegian State is the biggest shareholder, with about 48% of the total shares.

Sales by Norsk Hydro in the last financial year amounted to more than £20 million. Chief product is nitrogenous fertiliser.

£1¼-million paper machine

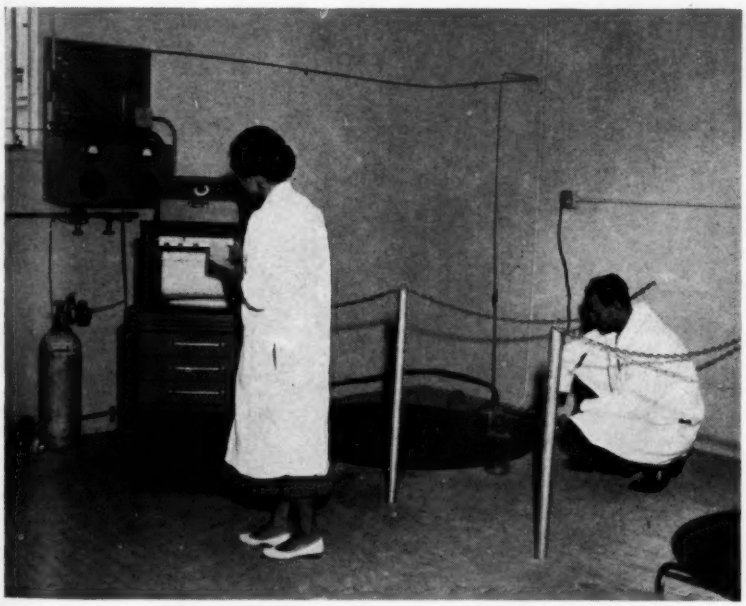
A/S Union, the Norwegian paper concern, has ordered a paper machine in Western Germany with a capacity of 45,000 tons p.a. of newsprint. The machine will be the largest so far acquired by Norway. When installed, three old machines now used by the company will be scrapped, so that the net increase in paper production will be 30,000 tons.

A/S Union stated recently that increased paper production was possible because a new process had been developed for using pine instead of spruce as raw material. Norway's spruce forests are already fully exploited, but there are good stocks of pine that now can be drawn on to supplement the raw material supply.

Atomics co-operation with Netherlands

A method of producing radioactive phosphorus with high specific activity, which has been worked out at the Institute for Atomic Energy at Kjeller, is believed to represent a considerable simplification compared with the methods used in the United States and Britain.

This development was mentioned by Gunnar Randers, director of the Institute, recently. He also said that the Institute was now supplying radioactive isotopes to Norway, Sweden, the Netherlands, Denmark and Germany and that the United States were also interested in receiving supplies. With the installations built, building, and planned, Norway in co-operation with the Netherlands would have ' one of the most solid atomic energy constellations outside the Great Powers,' he said.



ORGANIC HIGH-PRESSURE LABORATORY

To make it possible to carry out certain reactions in organic chemistry under high pressures in safety the Stanford Research Institute in the U.S. has established a special organic high-pressure research laboratory. In it research will be conducted into the oxidation of hydrocarbons, polymerisations, catalytic hydrogenations and other reactions necessitating moderate to high pressures.

Outstanding features of the new facility are two sunken steel caissons 10-ft. deep and 5 ft. in diameter which protect chemists and equipment from possible explosive reactions. One of the caissons contains a magnetically-stirred autoclave and the other a rocking-bomb assembly.

Controls and instrumentation are mounted outside the caissons and steel lids can be placed over the holes in extremely hazardous experiments. An exhaust fan is provided to evacuate toxic vapours.

Also in the laboratory are other rocker-bombs for lower-pressure, non-hazardous reactions.

UNITED STATES

Coal shipments by pipeline

The Pittsburgh Consolidation Coal Co. envisages shipments by pipeline over much greater distances than are now being planned. The company, which is the largest coal producer in the world, regards this as an insurance against possible future increases in rail freight rates on coal.

Pittsburgh is building a 110-mile pipeline from eastern Ohio to Lake Erie, which is expected to be operating by early 1957. A spokesman for the company said this new concept of moving coal to the point of use might be applicable to transmission of large tonnages over any conceivable distance. He added that the next decade would be able to compete with fuels having smaller or no transportation costs in supplying its share of the nation's energy needs.

New de-rusting process

An alkaline de-rusting process has been developed by the U.S. Army's Rock Island Arsenal. Effective in the removal of rust from ferrous metal parts preparatory to plating or other processing, the bath may also be used to clean brass or magnesium and strip phosphate coatings and paint. It may be used hot or cold, with or without electric current.

The formula for the Rock Island Arsenal bath is given in a technical report made available to industry through the Office of Technical Services of the Department of Commerce. It includes a section on disposal of cyanide wastes to avoid danger to fish, animals and human beings.

Expansion of U.S. chemical plant

The Monsanto Chemical Co. plans to expand its phthalic anhydride production facilities at Everett in order to provide a 60% increase in the plant's output of this basic organic acid.

Part of the expanded capacity is expected to go into phthalate ester production, which is now 50% higher than 1955 levels as the result of a recently completed expansion.

Plastics plant

A multi-million-dollar chemical plant in New Jersey is planned by Koppers Co. Inc. to manufacture its recently developed plastics material, *Super Dylanpolyethylene*. The rigid-type plastics material, which is claimed to withstand higher temperatures than regular polythene, has wide applications in industry and consumer products, including plastics pipe.

The new plant, to be situated on a

105-acre site in Woodbridge Township, will have an annual capacity of 30 million lb. of the new polythene. Ethylene, a raw material, will be piped to the plant from the Esso Standard oil refinery at Bayway. Production is scheduled to start in early 1957.

Unfreezing loaded coal

It was recently reported that a new process of heating loaded coal by infra-red rays was being tested in Toledo, Ohio. Imported from Germany, the process is designed to thaw coal frozen in railway wagons so that it can be unloaded in winter. Frozen coal has long been a problem for the railways and large coal users such as the steel industry and public utilities.

The process entails running a coal wagon between two banks of infra-red units. Natural or artificial gas is piped into the units and burns at the face of small ceramics giving off infra-red heat.

Celanese Corporation's progress

Net sales of Celanese Corporation of America increased to $177,502,026 in 1955 from $147,606,550 in the previous year, according to the company's annual report. The 1955 earnings, including tax refunds, were equivalent to $1.81 cents per share, compared with 32 cents in 1954.

Sales of Celanese plastics materials last year were the highest in the company's history. Plans have been made for construction of a new plant to manufacture rigid-type polythene resins by the newly developed low-pressure process. Sales of chemicals in 1955 also established a new high record, and a line of more than 40 chemicals are now being marketed. During the year, several new chemical products emerged from the development stage into large-scale production items. Among them were a new series of fire-resistant hydraulic fluids and lubricating specialities which offer diversified industrial and military uses.

U.S. acetylene products manufacture

The manufacture of high-pressure acetylene products on a full commercial scale, for the first time in the United States, has been started in Calvert City, Kentucky, by the General Aniline & Film Corporation.

The company has erected a $6-million plant for this purpose. Since 1947, a pilot plant for acetylene derivatives has been operated in New Jersey by the company.

These products will now be available to industry at new low commercial prices, in very large quantities, it is stated. The new products to be manufactured are propargyl alcohol, propargyl bromide, butynediol, butanediol, butyrolactone, pyrrolidone, methylpyrrolidone and polyvinylpyrrolidone.

New plastics plant

A new chemical plant to manufacture *Kralastic* plastics will be built by US Rubber Co.'s Naugatuck chemical division on a 150-acre tract of land near Baton Rouge, Louisiana. The plant, costing in excess of $5 million will more than double production capacity of the *Kralastic* plastics. Construction will start immediately with completion scheduled for around mid-1957.

Kralastic is a copolymer based on styrene, butadiene and acrylonitrile. Chemically-resistant pipe is its largest single use.

The Leonard Hill Technical Group—April

Articles appearing in some of our associate journals this month include:

Corrosion Technology—Calcium Plumbate in Anti-Corrosive Paint Pigments; A Scheme for the Examination of Corroded Metal Specimens; Corrosion Problems on the Texas Gulf Coast, 1; Plastic Pipes.

Paint Manufacture—The Fundamentals of Colour; Stearates for the Paint Industry; Will Aerosol Packages Stay?; Mechanical Handling Introduced for Packaging.

Food Manufacture—The Baking Industry; The Brewing Industry; Nutrition; Pectin Production at Hereford; The Dairy Industry; 'Synthetic' Foods—Indian Research.

Manufacturing Chemist—Boots Pure Drug Co.'s new Cortisone Plant; Solubilisation with Amphiphilic Compounds; U.S. National Bureau of Standards Radiochemistry Laboratory; Antibiotics; Cosmetics and Toilet Preparations; Fertilisers and Plant Nutrients.

Fibres—Finding New Inhibitors to Gas Fading for Coloured Acetate Goods; The Vieluba Meter for Measuring Thread Regularity; The Resin Bonding of Hardwood Fibres in Offset Papers.

Dairy Engineering—Boras Central Dairy, Sweden; The Dairy Industry in France; World Trade in Dairy Produce; British Dairy Plant Abroad; Liverpool—Last Stronghold of Town Cowkeepers.

Building Materials—The Architectural Use of Building Materials; Materials Used in New Technical High School; Developments in the Application of Concrete to Housing.

Muck Shifter—The Construction of a Great Earth-Filled Dam; Handling Coal Sludge Deposits; Tin Dredging; Drilling in a Lead Mine.

MEETINGS

Institution of Chemical Engineers

April 10. 'Patents in Chemical Engineering,' by H. I. Downes, 5.30 p.m., Geological Society, Burlington House, London, W.1.

April 11. 'Commissioning a Major Coal-Preparation Plant,' by A. J. C. Older, 7 p.m., the University, Leeds.

April 14. 'Grinding of Quartz-Limestone Mixtures,' by S. W. F. Patching and J. A. Holmes, 3 p.m., College of Technology, Manchester.

April 18. 'Thermal Insulation,' 7 p.m., Grosvenor Hotel, Chester. Joint meeting of North-Western Branch and Chester Section of the Institute of Petroleum.

Society of Chemical Industry (Chemical Engineering Group)

April 10. 'The Design of Dual Firing Systems for Coal and Oil,' by J. H. Bock, Middlesbrough.

Institution of Mechanical Engineers

April 27. 'The Impact of Engineering on Society,' by Sir Maurice Bowra, 5.30 p.m., 1 Birdcage Walk, London, S.W.1. Joint meeting with the I.C.E. and I.E.E.

May 1. 'Pumping Problems, Present and Future,' by H. Addison, 5.30 p.m., Institution of Civil Engineers, Great George Street, London, S.W.1. Joint meeting with the I.C.E.

May 4. 'Three-Dimensional Motion in Axial Flow Impellers,' by S. P. Hutton; 'The Performance of an Axial Flow Pump,' by E. A. Spencer, 5.30 p.m.

Incorporated Plant Engineers

April 27. 'Atomic Energy,' by Dr. J. H. Fremlin, 7.30 p.m., Imperial Hotel, Birmingham.

April 19. 'Electronics in Industry,' by A. Worland, 7.30 p.m., Golden Lion Hotel, Blackburn.

Society of Instrument Technology

April 24. 'Dynamic Characteristics of Some Neutralisation Processes and of Glass *p*H Electrodes,' by Prof. Ir. H. Kramers, 6.30 p.m., Manson House, Portland Place, London, W.1.

Chemical Society

May 2. 'Seaweeds and their Utilisation,' by Dr. F. N. Woodward, 7.45 p.m., University College, Dublin. Joint meeting with the Institute of Chemistry of Ireland, the Royal Institute of Chemistry and the Society of Chemical Industry.